SORVALL®
CENTRIFUGES

Parts Section
Updated March '02

SORVALL®
TC6®

IMPORTANT INFORMATION REGARDING USE OF THIS MANUAL
READ BEFORE USING

This manual provides technical information for the proper servicing of the product(s) specified. This manual is intended only for use by Sorvall Service personnel, or by qualified technicians who have been trained by Sorvall in the safe, proper servicing of that product.

This manual has been designed as a supplement to training, not a substitute for training; servicing *should not* be attempted by untrained personnel. Technicians who have not been trained by Sorvall are not familiar with the product design or the hazards that may be encountered during servicing. In addition, lack of training can result in faulty repair – possibly making subsequent product use dangerous, or product yields unreliable.

Although content of this manual is believed to be adequate for its intended use, Sorvall makes no representation or warranty regarding completeness, adequacy or otherwise (not even as a supplement to a given training course) and assumes no obligation or liability. In the event a qualified, trained technician is unable to repair the product using this manual, Sorvall Technical Service should be contacted for additional guidance.

Service Manual

PN 78006

OPERATING INSTRUCTIONS

SORVALL® TC6®

Tabletop Centrifuge

Sorvall Products, L.P.
Newtown, Connecticut
U.S.A.

SORVALL®
CENTRIFUGES

PN 78006-1
Issued August 1996

This manual is a guide for service of the

SORVALL® TC6® Tabletop Centrifuge

Data herein has been verified and validated and is believed adequate for the intended use of the centrifuge. Because failure to follow the recommendations set forth in this manual could produce personal injury or property damage, always follow the recommendations set forth herein. Sorvall does not guarantee results and assumes no obligation for the performance of rotors or other products that are not used in accordance with the instructions provided. This publication is not a license to operate under, nor a recommendation to infringe upon, any process patents.

This service manual is intended as a service aid. While the manual is kept current and includes information regarding significant design changes, specific designs may still vary from centrifuge to centrifuge.

This service manual is intended for use only by service personnel who have been trained by DuPont. Due to the high electrical potential in this centrifuge, untrained individuals must not attempt any of the procedures in this service manual.

WARNINGS, *CAUTIONS*, and *NOTES* within the text of this manual are used to emphasize important and critical instructions:

WARNING: A Warning informs the operator of a hazard or an unsafe practice that could result in personal injury, affect the operator's health, or contaminate the environment.

CAUTION: A Caution informs the operator of an unsafe practice that could result in damage of equipment.

NOTE: A Note highlights essential information.

W A R N I N G

When using radioactive, toxic, or pathogenic material, be aware of all characteristics of the material and the hazards associated with it. In the event that leakage or rotor failure occurs, neither the centrifuge nor the rotor can protect you from the particles dispersed into the air. To protect yourself, we recommend additional precautions be taken to prevent exposure to these materials, for example, controlled ventilation or isolation. DO NOT USE MATERIALS CAPABLE OF PRODUCING FLAMMABLE OR EXPLOSIVE VAPORS.

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Section 1: INTRODUCTION and DESCRIPTION

This manual is a service guide for the SORVALL® TC6® Tabletop Centrifuge. It contains descriptive information, repair and replacement procedures, schematics, troubleshooting, calibrations, and an illustrated parts list for ordering replacement parts.

1-1. Intended Use of Manual

W A R N I N G

To avoid personal injury, all replacement and calibration procedures should be performed by qualified service personnel.

This manual is for qualified service personnel who are familiar with factory methods for performing repairs, adjustments and calibrations.

Warnings, Cautions, and Notes are used throughout this manual to emphasize important and critical instructions. Service personnel are expected to be familiar with their meaning (see page ii) and to read them before servicing the centrifuge.

1-2. Service Decontamination Policy

W A R N I N G

Because of the characteristics of the samples likely to be processed in this centrifuge, biological or radioactive contamination may occur. Always be aware of this possibility, and take normal precautions. Use appropriate decontamination procedures should exposure occur.

If a centrifuge or rotor that has been used with radioactive or pathogenic material requires servicing by Sorvall personnel, either at the customer's laboratory or at a Sorvall facility, comply with the following procedure to ensure the safety of all personnel:

1. Clean the centrifuge or rotor to be serviced of all encrusted material and decontaminate it prior to servicing by the Sorvall representative or returning it to the Sorvall facility. There must be no radioactivity detectable by survey equipment.

   The SORVALL® Rotors, Tubes, Bottles, Adapters and Accessories Catalog contains descriptions of commonly used decontamination methods and a chart showing method compatibility with various materials. This service manual contains specific guidance about cleaning and decontamination methods appropriate for the centrifuge or rotor it describes (see paragraph 7-1).

Clean and decontaminate your centrifuge or rotor as follows:

For TC6® tabletop centrifuges:

a. Remove rotor from the rotor chamber.
b. Remove motor cover and wash with appropriate decontaminant.
c. Decontaminate door, rotor chamber, chamber door seal, and drive, using an appropriate method.

For rotors:

Remove tubes, bottles, and adapters from the rotor and decontaminate rotor using an appropriate method. If tubes or rotor caps are stuck in the rotor, or the rotor door is stuck, notify Sorvall representative; be prepared with the name and nature of the sample so the Sorvall Chemical Hazards Officer can decide whether to authorize the rotor's return to a Sorvall facility.

2. Complete Decontamination Information Certificate (SORVALL® products Form No. IPDP-59 or E53603) and attach it to the centrifuge or rotor before servicing or returning to Sorvall facility. Certificates are included in the back of this manual. Additional certificates are available from the local Account Representative or Field Service Engineer. In the event that these certificates are not available, it will be acceptable to include a written statement certifying that the unit has been properly decontaminated and outlining the procedures used.

If the centrifuge or rotor must be returned to a Sorvall facility:

1. Contact your Sorvall representative to obtain a Return Service Order Number (RSO No.). Be prepared with the name and serial number of the centrifuge or rotor and the repairs required.

2. Send item(s) with the RSO No. clearly marked on the outside packaging to the address obtained from your Sorvall representative.

NOTE United States federal regulations require that parts and centrifuges *must* be decontaminated before being transported. Outside the United States, check local regulations.

If a centrifuge or rotor to be serviced does not have a Decontamination Information Certificate attached and, in Sorvall's opinion presents a potential radioactive or biological hazard, the Sorvall representative will not service the equipment until proper decontamination and certification is complete. If Sorvall receives a centrifuge or rotor at its Service facilities which, in its opinion, is a radioactive or biological hazard, the sender will be contacted for instructions as to disposition of the equipment. Disposition costs will be borne by the sender.

NOTE The Field Service Engineer will note on the Customer Service Repair Report if decontamination was required and, if so, what the contaminant was and what procedure was used. If no decontamination was required, it will be so stated.

1-3. Warranty Responsibility

Whenever service of the centrifuge is attempted by anyone other than an employee of Sorvall or an authorized representative, the individual is assuming the risk of voiding the centrifuge warranty, which is as follows:

Sorvall Products, L.P. makes no warranty of any kind, expressed or implied, except as stated in this warranty policy.

The SORVALL® TC6® Tabletop Centrifuge is warranted to be free from defects in materials and workmanship for a period of one year from the date of delivery. Sorvallwill repair or replace and return free of charge any part which is returned to its factory within said period, transportation prepaid by user, and which is found upon inspection to have been defective in materials or workmanship. This warranty does not apply to any damage to any instrument resulting from: normal wear and tear; misuse; abuse; use of electrical currents or circuits other than those specified on the plate affixed to the instrument; or use of any rotor other than those intended for use in this instrument.

Sorvall reserves the right to change, alter, modify or improve any of its instruments without any obligation whatsoever to make corresponding changes to any instrument previously sold or shipped.

The foregoing obligations are in lieu of all other obligations and liabilities including negligence and all warranties, of merchantability or otherwise, expressed or implied in fact or by law, and state our entire and exclusive liability and buyer's exclusive remedy for any claim or damages in connection with the sale or furnishing of goods or parts, their design, suitability for use, installation or operation. Sorvall will in no event be liable for any special or consequential damages, and our liability under no circumstances will exceed the contract price for the goods for which liability is claimed.

1-4. Centrifuge Description

The TC6® is a lowspeed, non-refrigerated tabletop centrifuge that features digital readout displays, a dc brushless (maintenance free) motor, a closed-loop speed control, a removable stainless steel rotor chamber, ergonomically designed front panel control knobs and switches, and has a see-through chamber door that allows rotor calibration and visual inspection of a run in progress. The chamber door is counterbalanced for easy opening and safe closing. The door latch automatically locks when the chamber door is closed and an interlock prevents the chamber door from being opened during operation.

1-5. Specifications

Maximum Operating Speed:	6000 rpm*
Maximum heat output during operation:	650 Btu/hour (190 Watts)
Electrical Requirements:	100 - 120 Vac, 60Hz, 3.15A, single phase 220 - 240 Vac, 50 Hz, 2A, single phase
Dimensions:	
Width	39.4 cm (15.5 inches)
Depth	55.9 cm (22.0 inches)
Height	26.7 cm (10.5 inches)
Height (with door open)	78.7 cm (31.0 inches)
Mass (Weight):	31 kg (70 lbs)
Decibel Level:	<60 dB at 3500 rpm
Operating Temperature Range:	10°C to 35°C (50°F to 95°F)
Relative Humidity (Normal Operating Range):	20% to 70%

*Speed in revolutions per minute (rpm) is related to angular velocity, ω, according to the following:

$$\omega = (\text{rpm})\left(\frac{2\pi}{60}\right) = (\text{rpm})\ (0.10472)$$

Where ω = rad/s. All further references in this manual to speed will be designated as rpm.

1-6. Controls, Displays, Switches and Indicators

Figure 1-1 shows the TC6® control panel and provides a brief description for each control, display, switch and indicator. Table 1-1 (on the next page) gives a complete description.

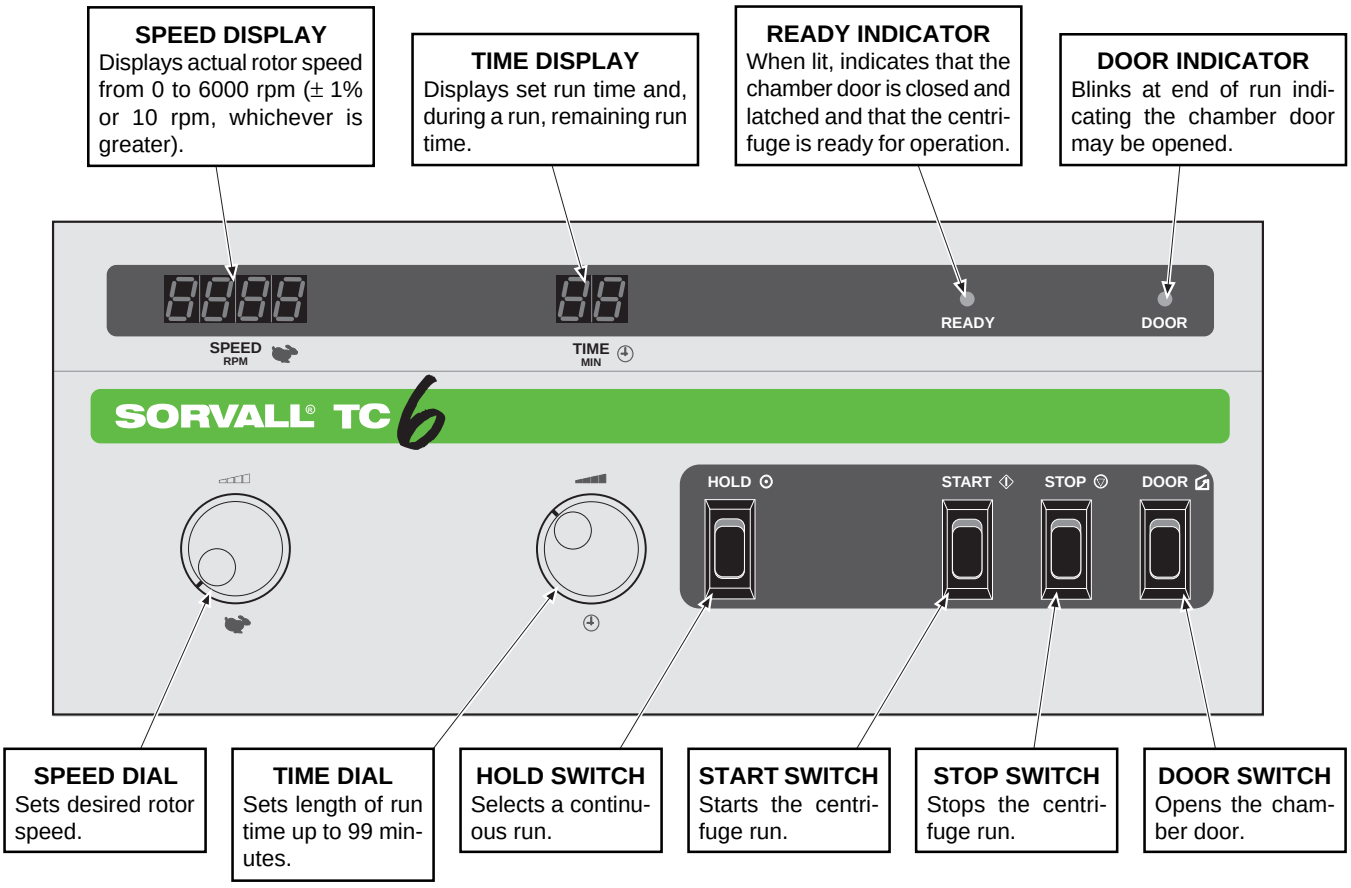

Figure 1-1. TC6® Controls and Indicators

Table 1-1. Description of Controls, Displays, Switches and Indicators

SPEED display	Indicates actual rotor speed from 0 to 6000 rpm (± 1% or 10rpm, whichever is greater).
TIME display **MIN**	Indicates set run time at the beginning of the run and the remaining run time after the START switch is pressed. In HOLD mode, two dashes are displayed.
READY indicator light	When lit, indicates that the chamber door is closed and latched and that the centrifuge is ready for operation.
DOOR indicator light	At the end of the run this light blinks indicating that the rotor has stopped spinning and that the chamber door may be opened.
SPEED dial	Sets the desired rotor speed in rpm. As indicated by the symbol, turn the dial to the right to increase speed.
TIME dial	Sets length of run time up to 99 minutes.
HOLD switch	Selects a continuous run (two dashes will appear in the TIME display to indicate a run in HOLD mode).
START switch	Starts the centrifuge run.
STOP switch	Stops the centrifuge run.
DOOR switch	At the end of a run, after the rotor has stopped spinning and the DOOR light blinks, this switch releases the chamber door.
POWER switch (NOT SHOWN)	The power switch is a rocker switch that toggles on and off. When set to "**I**", applies power to the centrifuge.

Contents
Section 2. Installation and Operation

Section 2: INSTALLATION and OPERATION

This section contains information to install and operate your SORVALL® TC6® Tabletop Centrifuge.

2-1. Inspection

WARNING

The TC6® weighs 70 lbs. Refer to the unpacking instructions for proper care when lifting and installing the centrifuge. Failure to use proper lifting techniques can result in personal injury and/or possible damage to the centrifuge.

CAUTION

Do not lift the centrifuge by the front panel or the door. To do so can result in damage to these parts.

When you receive your centrifuge, carefully inspect it for any signs of shipping damage. If you find damage, report it immediately to the transportation company and file a damage claim, then notify Sorvall.

Check the parts received with the centrifuge against the shipping list; if any parts are missing, contact Sorvall (see office list in back of manual).

2-2. Preinstallation Requirements

CAUTION

The centrifuge can be damaged if connected to the wrong voltage. Check the voltage before plugging the centrifuge into any power source. Sorvall is not responsible for incorrect installation.

The TC6® centrifuge is ordered for a specific voltage. The nameplate on the back of the centrifuge tells the voltage ordered. Before using the TC6®, be sure the proper operating voltage and corresponding fuse is selected. If required (for instruments serial number 9501733 and below), the voltage setting and fuses can be changed (refer to page 2-2, paragraph 2-4, Voltage Selection for procedure to change the voltage).

Other preinstallation requirements include:

- providing a flat, level surface to support the weight of the centrifuge (31 kg; 70 lbs),
- allowing adequate space for proper air circulation (5 cm; 2inches),
- allowing for the proper height clearance to open the chamber door (78.7 cm; 31.0 inches); and
- providing the proper electrical requirements.

CAUTION

If the power cord is connected to the wrong voltage, it can cause damage to the centrifuge. Check the voltage listed on the nameplate before plugging the power cord into the power source. Sorvall is not responsible for incorrect installation.

2-3. Electrical Requirements

The centrifuge has specific power requirements and must be connected to the correct power supply for proper performance. The nameplate on the back of the centrifuge specifies one of the following:

100 - 120 Vac, 60 Hz, single phase, 3/15 amps*
220 - 240 Vac, 50 Hz, single phase, 2 amp*

Check line voltage with a voltmeter. Then, verify that the voltage indicated on the nameplate on the back of the centrifuge agrees with the measured line voltage.

If the line voltage is beyond the ±10% tolerance (of nominal) given, the result can be variations in the performance specifications and damage to the centrifuge.

The power cord has a keyed plug that inserts into a receptacle at the back of the centrifuge. The other end of the power cord has a three-prong molded cap with a ground pin and parallel blades. (60 Hz instruments require receptacle NEMA 5-15R and 50 Hz instruments require NEMA 6-15 R.).

For connection to other receptacles, the power cord may have to be replaced. Follow local electrical regulations.

Check that the gound lug of the electrical plug is properly grounded and is shorted to the frame of the centrifuge.

2-4. Voltage Selection (SN 9501733 and Below)

The voltage is set by the voltage selector (in the fuse block) located in the power connector on the back of the TC6® (refer to figure 2-1 for SN 9501733 and below). The current voltage setting (100, 110**, 220, or 240) is displayed in the window of the fuse block.

To change the voltage:

1. Unplug the power cord from the wall receptacle and from the power connector.

2. Squeeze the two tabs located on either side of the fuse block and carefully remove the fuse block from the power connector.

NOTE Voltage can only be changed on instruments with serial numbers 9501733 and below. Instruments with serial numbers 9501734 and above must be ordered prewired for specific voltages.

*CSA and UL Certified.
**For 120 V operation, the voltage selector is set to 110.

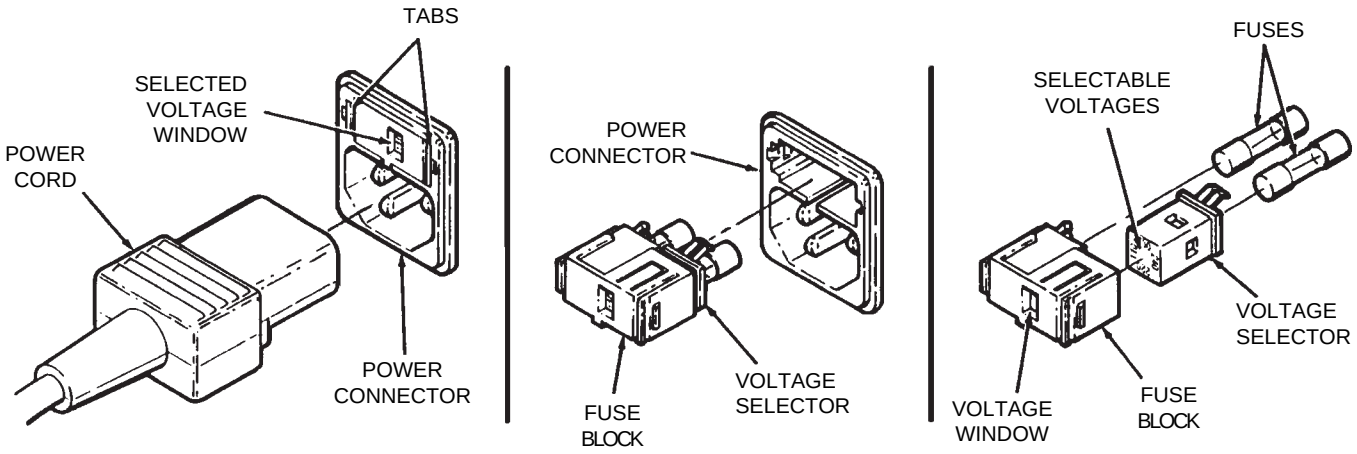

Figure 2-1. Voltage Selection (SN 9501733 and below)

CAUTION

When changing the voltage setting, be sure that the voltage selector is installed so that the voltage displayed in the voltage window matches the intended input voltage. Also, be sure that the proper fuses have been installed, and that you are using the proper power cord. Incorrect installation can result in damage to the centrifuge. Sorvall is not responsible for incorrect installation.

3. Gently pull the voltage selector from the fuse block.

4. Rotate the voltage selector until the desired voltage is aligned with the window in the fuse block. Then, reinstall the voltage selector into the fuse block.

5. Check that proper fuses are installed. Fuses are Type T, 250 V, but change amperage rating depending on the voltage selected:

   - *100 or 110 setting* requires two 3.15-amp fuses, (PN 91428),
   - *220 or 240 setting* requires two 2-amp fuses, (PN 91203).

   Change fuses if necessary.

6. Reinstall the fuse block into the power connector and plug in the centrifuge power cord.

NOTE If the voltage was changed from 100-110 setting to 220-240 setting, a different power cord is required.

2-5. Installation

C A U T I O N

Do not lift the centrifuge by the front panel or the chamber door. To do so can result in damage to these parts.

If the power cord is connected to the wrong voltage, it can cause damage to the centrifuge. Check the voltage listed on the nameplate before plugging the power cord into the power source. Sorvall is not responsible for incorrect installation.

Do not operate the centrifuge without making sure the rotor is properly balanced. Also, when installing a rotor, carefully place it on the centrifuge drive spindle. The centrifuge spindle bearings can be damaged if rotor is dropped on the drive spindle.

To install the centrifuge:

1. Place the centrifuge on a sturdy bench or work table that will support its weight, leaving space for sample preparation. Be sure to leave a minimum clearance of 10 cm (4 inches) on all sides for proper air circulation.

2. Make sure the centrifuge is level.

3. Make sure the centifuge is set for the proper voltage (see page 2-3, Voltage Selection).

4. Make sure the power switch is set to **"O"** (OFF position).

5. Insert the universal keyed end of the power cord into the power connector at the back of the centrifuge and the other end into a wall receptacle. The centrifuge is now ready for use.

2-6. Rotor Considerations

a. Rotor Temperature

W A R N I N G

Blocking the air flow entering and/or exiting the TC6® centrifuge will cause an increase in temperature within the rotor chamber. The temperature increase can temporarily distort non-metal surfaces allowing particles to exit the rotor chamber resulting in personal injury and/or centrifuge damage should tube breakage or rotor failure occur.

When loading the rotor, be sure not to exceed the maximum compartment mass of the rotor (see the individual rotor instruction manual). If maximum compartment mass is exceeded, maximum rotor speed must be lowered as described in the rotor instruction manual, Compartment Loads in Excess of Design Mass. Failure to do so can cause rotor failure which could result in personal injury and/or centrifuge damage.

Centrifugation creates an increase in rotor temperature. The increase in temperature is caused by variables including rotor speed, length of the run, and the type of rotor.

Air flow through the TC6® Centrifuge is designed to minimize the increase in rotor temperature. Air enters through the air vent in the front panel and exits through the fan vent located at the back of the centrifuge.

When running temperature-sensitive material, a trial run is recommended.

b. Rotor Installation, Loading and Balancing

Before placing the rotor on the drive spindle, make sure that there are no loose objects inside the rotor chamber; for example, clips, tubing, tape, or labels, and that the rotor centerhole and drive spindle are clean and free of nicks and scratches. Wipe these surfaces before each use.

Gently place the rotor body on the tapered spindle of the centrifuge, aligning the shaft pin with the slots in the rotor. Secure the rotor to the drive spindle by turning the rotor locking knob clockwise.

CAUTION

Do not operate the centrifuge without making sure the rotor is properly balanced. Also, when installing a rotor, *carefully* place it on the centrifuge drive spindle. The centrifuge drive spindle bearings can be damaged if the rotor is dropped on the drive spindle.

WARNING

When using radioactive, toxic, or pathogenic materials, be aware of all characteristics of the materials and the hazards associated with them in the event leakage occurs during centrifugation. If leakage does occur, neither the centrifuge nor the rotor can protect you from particles dispersed in the air. To protect yourself, we recommend additional precautions be taken to prevent exposure to these materials, for example, use of controlled ventilation or isolation areas.

Always be aware of the possibility of contamination when using radioactive, toxic, or pathogenic materials. Take all necessary precautions and use appropriate decontamination procedures if exposure occurs.

The use of sealed rotors, buckets and/or sample containers will provide increased protection from contamination during routine operation. However, these items will not guarantee contamination protection from accidents resulting in damage to the rotor or buckets. Do not run hazardous material in the centrifuge unless it is placed in a biohazard enclosure and operated using appropriate safety precautions.

NOTE The rotor locking knob cannot be tightened if the rotor is not properly installed on the drive spindle.

Refer to the rotor instruction manual for bucket loading and balancing procedures as well as information regarding the selection and use of tubes, bottles, and adapters.

2-7. Running Hazardous Material

Because the centrifuge chamber of the TC6® is not designed for biocontainment, some vapors or aerosols released from uncapped, leaking or broken tubes may leak from the chamber during operation. Once a run is completed and the chamber door is opened, the vapors or aerosols which have concentrated in the chamber will be released into the laboratory area. For this reason, when materials which are radioactive, pathogenic, toxic, or otherwise hazardous in nature are to be run, the centrifuge should be located in a biohazard safety enclosure and operated using all appropriate safety precautions. If desired, we recommend the use of sealed bucket assembly (Catalog No. 78016) to offer increased protection from contamination from uncapped, leaking or broken tubes.

NOTE The sealed bucket assemblies (Catalog No. 78016) are designed to seal tightly during operation and meet the British Standards BS 4402:1982 Appendix D. They have been tested at the Public Health Laboratory Service Centre for Applied Microbiology and Research, Porton Down, United Kingdom, and found suitable for use with materials up to ACDP Category 3.

Use appropriate decontamination procedures should exposure to any hazardous material occur. Read paragraph 1-2, page 1-1 for the procedure to follow if a centrifuge or rotor that has been used with a hazardous material must be returned to our service facilities for repair.

2-8. Operation

W A R N I N G

Be sure the rotor chamber and chamber door gasket are installed before the centrifuge run. Operating the centrifuge without these parts in place could allow small particles to exit the rotor chamber in the event of a rotor failure.

C A U T I O N

Be sure the rotor is properly balanced and seated on the drive spindle. All four buckets must be used on every run (even if empty). See rotor instruction manual.

To perform the run:

1. Set the POWER switch to "I".
2. Press the DOOR switch to release the chamber door.
3. Install the rotor on the drive spindle and close the chamber door. When properly closed, the lid latch automatically locks the door and the READY indicator light comes on.
4. Set the SPEED dial to the desired run speed.

NOTE Selected run speed is to be verified and adjusted during the run after the value shown in the SPEED display has stabilized. Adjust the SPEED dial until the SPEED display indicates desired run speed (in rpm). If it is not disturbed, the SPEED dial will retain its position, allowing for run-to-run repeatability.

5. Turn the TIME dial to the desired run time (the run time, in minutes, will appear in the TIME display); or press the HOLD switch to ON for a continuous run and two dashes (--) will appear in the TIME display.
6. Press START switch to begin run.

NOTE If the door is not properly closed, the READY indicator light will not come on and the rotor will not spin when the START switch is pressed.

To end a run before the selected run time has elapsed or to end a run set to HOLD, press the STOP switch.

7. At the end of the run, the DOOR indicator light blinks indicating that the chamber door can be opened. Press the DOOR switch to open the chamber door.

   Remove the sample from the rotor, close the chamber door, and set the POWER switch to "**O**".

NOTE The speed and time values selected at the beginning of the run are automatically retained unless the power cord is disconnected from the power source. To do another run with the same run speed and time parameters: prepare the rotor, install it in the centrifuge, close the chamber door, and press the START switch.

2-9. Emergency Sample Recovery

If the main power shuts off because of a power failure or system malfunction, the chamber door will not open. A mechanical override is provided to allow sample recovery in the case of an emergency.

WARNING

This procedure is included for *emergency sample recovery only* and should never be used for any purpose other than those explained in this section.

When the main power shuts off, the brake will not operate. Unplug the centrifuge plower cord and wait until the motor stops spinning *before* using the mechanical override.

The mechanical override is located below the air inlet vent in the front panel, as shown in figure 2-3. To operate the override, insert the end of the override key (PN 78170 supplied), at a slight upward angle 2/3 of the way into the hole. Carefully move the key left-to-right until you locate the solenoid shaft. Slowly move the end of the key downward to contact the washer located at the bottom of the shaft. With the key pressed tight against the solenoid shaft, use the key as a lever to apply downward pressure on the washer to release the chamber door.

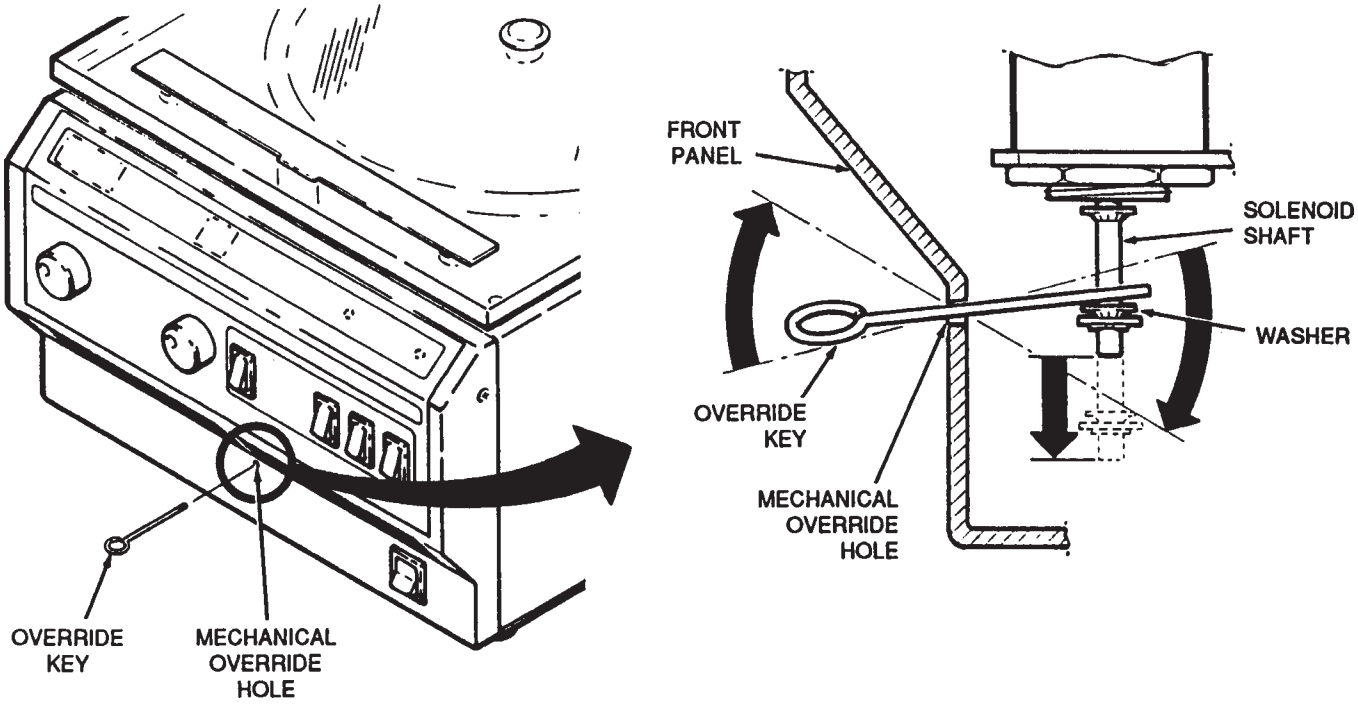

Figure 2-2. Location of the Mechanical Override

SORVALL® Centrifuges

TC6® TABLETOP CENTRIFUGE

INSTALLATION CHECKLIST

Institution _____
Street Address _____
_____
City _____
State/Province _____
Postal Code _____
Country _____
Phone No. _____

Date _____
Serial Number _____
Packing List No. _____
User _____
Installed by _____

Inspection (paragraph 2-1)

☐ Shipping damage
☐ Accessories included

Preinstallation (paragraph 2-2)

☐ Confirm voltage on instrument

Electrical Requirements (paragraph 2-3)

☐ Line voltage
☐ Ground Continuity

Voltage Selection (paragraph 2-4)

☐ Check fuse block/correct fuses

Installation (paragraph 2-5)

☐ Sturdy bench
☐ Level surface

Operation (paragraph 2-8)

☐ Perform run
☐ Acceleration time
☐ Deceleration time
☐ Door Latch

Comments: _____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Signature of Installer _____

Date

Contents
Section 3. System Descriptions

Section 3: SYSTEM DESCRIPTIONS

3-1. General System Description

The TC6® is an assembly that consists of the following:

- Power System
- Drive Motor System
- Control System
- Input/Output System
- Cabinet System
- Ventilation System
- Containment System

The Power System consists of the cord, voltage selector (SN 9501733 and below), power supply, and electrical connectors. It takes electricity from the electric outlet, converts it to low voltage and then distributes it to the other instrument systems.

The Drive Motor System consists of the motor, drive electronics and drive mount hardware. It receives controlled voltage from the control system to spin the rotor while providing support for itself and the rotor system.

The Control System consists of electrical circuits that are located on printed circuit boards to control operation of the motor speed, the timer and the latch mechanism.

The Input/Output System is a user interface system that consists of knobs, switches, and displays. It allows the user to input run parameters and also monitors a run in progress.

The Cabinet System consists of the upper and lower frame sections. This system forms the main body of the centrifuge and supports the other instrument systems.

The Ventilation System consists of a fan, gaskets and baffles. It directs air movement in the centrifuge to cool the circuits and motor and also seals the rotor chamber to minimize windage.

The Containment System consists of radial and vertical containment sub-systems. The radial sub-system is the guard and containment rings and their supports. The vertical containment sub-system is the door, latch and striker, and the mounting hardware. The containment system is designed to contain any parts or fragments that may result from a rotor failure.

3-2. Power System

Theory of Operation

The electrical power portion of this centrifuge starts in the line cord entry module. This module accepts a standard three wire power cord. Both sides of the line are fused. The 100 - 120 volt centrifuges are fused at 3.15 amps and the 220 - 240 volt centrifuges at 2 amp. (SN 9501733 and below), 120 V (±10%) and 230 V (±10%) (SN 9501734 and above). This centrifuge is designed to work on either 50 or 60 hertz at any of the input voltages. No changes are necessary to accommodate different line frequencies.

The other portion of the power system is the dc power supply. This is a dual supply generating nominally 30volts at 10amps and 5volts at 500milliamps. Ther e is a fast acting fuse of 6.3amps on the 30volt secondary of the transformer and a fast-acting fuse of 1.6 amps on the 5volt secondary of the transformer . The bridge rectifiers and 5 volt regulator are heatsinked to the chassis. The 30volt supply is used by the motor control circuitry, the motor, and the latch release solenoid. The 5volt supply is for powering the displays, speed and timer logic; and the operator I/O logic.

3-3. Drive Motor

Theory of Operation

The motor is a brushless dc type. Four Ferrite magnets are adhesive bonded to the steel shaft to make up the rotor. Arranged around the rotor in the case are three excitation coils. To sense motor position, threeHall-ef fect devices are mounted at the bottom of the case.

3-4. Brushless Motor Drive Electronics

The TC6® drive is a type of power inverter motor drive. The functional purpose is to convert raw single phase ac power into synchronous three-phase power to the motor. This is accomplished in several stages. The following is a brief description of how the internal power conversion process occurs.

Power Conversion from ac to dc – The ac power source may be selected for a nominal voltage of 100 - 120 or 220 - 240 volts ac-RMS at a frequency of between 48 to 62 Hz. Only single phase ac is used. Raw ac, used for the motor power, passes into a full wave bridge

rectifier and then into filter capacitors. The combination of these components provides a nominal 30 volt unregulated dc power source.

Power Inversion from dc to ac – The unregulated dc power available in the TC6® must be converted back to phased ac power for the motor to operate. This process is called inversion. For proper control of motor rotation, the drive must synchronize the application of power precisely with the rotational position of the rotor. This process is commonly referred to as commutation. The motor used in the centrifuge requires three-phase ac power for commutation.

The three-phase ac power used to "commutate" the motor is phase displaced in time by 120 electrical degrees. The ac power delivered is pulsed square waves and provides variable frequency ac to the motor. This feature enables the motor to operate at variable speeds.

The three-phase ac power delivered to the motor is developed by an active circuit network consisting of six power transistors. This network is called the output bridge. In order to sustain the rotation of the centrifuge the drive continuously processes and decodes rotor position information. This information is used to sequentially apply power from the output bridge to the motor.

It is not sufficient to precisely control the motor through commutation alone. The power applied to the motor must be carefully metered in order to throttle both torque and speed. This is accomplished through a technique called pulse width modulation, or PWM.

The PWM technique provides a method of efficient power control through the use of high frequency output bridge modulation. In effect, as each motor winding is turned on in sequence during motor rotation, PWM is superimposed upon the normal commutation signals. PWM results in the application of power to the motor by chopping it on and off at a high rate (24 kHz). This chopping scheme controls average motor current by varying the ratio of "on time" versus "off time" for each PWM cycle. This chopping scheme provides proportional output torque from the motor through the direct adjustment of the average motor current.

The drive limits torque by continuously monitoring the electrical current to the motor and comparing it to the commanded level requested by the control setting. The difference between these two levels results in an error signal which is then converted to a PWM ratio. This PWM is used to modulate the output bridge as described above.

a. Theory of Operation

The drive is built with Motorola's MC33035 and a support chip MC33039.

The MC33035 is a 24-pin linear integrated circuit (I.C.) that operates as the control center for the brushless dc motor control system. The main functions of MC33035 are to decode the signals from the Hall-effect sensors and generate logic for electronically commutating the motor. The commutation logic is internally delivered to the six output drivers consisting of three open collector NPN transistors that drive the upper legs of the bridge and three totem pole drivers that control the devices. The open collector outputs can sink 50 mA. With some additional circuitry this allows control of either N-channel MOSFETs for higher power applications or P-channel MOSFETs if a simple interface is desired. Since the three lower totem pole outputs can source and sink 10 mA, they can drive power MOSFETs directly.

b. Fault Management

The MC33035 can detect and manage several types of faults. A common method of overcurrent detection is to tie the sources of the lower three transistors together and return them to the negative supply rail through a current sense resistor. The sense voltage, which is proportional to load current, is delivered into a comparator on board the MC33035. The comparator then delivers an RS flip-flop, which ensures that the output drivers will turn off the power transistors for the remainder of the oscillator cycle if an overcurrent condition is detected. Without the internal flip-flop, the overcurrent protection loop would rapidly cycle on and off about the comparator's threshold, causing excessive power transistor heating.

In addition to overcurrent management, the MC33035 provides undervoltage lockouts that terminate the drive to the output transistors if any of three conditions occur:

- insufficient voltage to operate the I.C.;
- insufficient voltage to drive the power MOSFET gates; or
- output drivers turn the power transistors off when the MC33035 does not sustain its on-board 6.25 V reference.

An invalid set of Hall-effect signals or excessive temperature will also cause shutdown.

Whenever any fault condition exists, an NPN transistor capable of sinking 16 mA pulls the Fault Output pin low.

c. Control Features

The MC33035's circuitry contains all except one major element for closed-loop speed control. The missing element is that which monitors motor rpm (speed) and generates a signal proportional to motor speed, a function that has been the domain of a tachometer Once provided with a motor speed signal, the MC33035's high performance error amplifier and its internal oscillator form the last major links in the speed control loop.

The MC33035's on-board oscillator operates at a frequency set by an external resistance/capacitance (R-C). Each cycle capacitor is charged from the reference output through a resistor and then rapidly discharged through an internal transistor.

At each positive or negative transition of the Hall-effect sensors, the MC33039 generates a pulse with a fixed on time. The output signal can then be filtered to obtain a voltage proportional to motor speed. Design of an MC33035/39 based system should begin with setting the system timing, which originates in the MC33039. Selection of timing components for MC33039 is based on the desired maximum motor rpm. For the motor used in this application, there are two electrical degrees for every mechanical degree since the permanent magnet on the rotor has two pairs of poles. Therefore, for every mechanical revolution each Hall-effect sensor delivers two pulses and the three sensors generate six pulses. The MC33039 generates 12 pulses for each revolution, one for each rising and falling edge.

For a given maximum rotor speed, the output pulse width has a maximum limit. For example, the maximum speed is 6000rpm, which is 100r evolutions per second, the MC33039 will generate 100x12, or 1200pulses per second. The >1kHzfr equency determines that the maximum pulse width must be less than 1ms. One can determine that R1 and C1 values of 30k and 22nF r esults in a pulse width of 600 µs. To set the system PWM frequency, refer to the MC33035's data sheet. There it shows that setting R2 and Cw to 5.1k and 0.01 µF gives a nominal PWM frequency of 24kHz, just above the audible range.

Both inputs and the outputs of the MC33035's error amplifier are accessible to accommodate various control methods. For open-loop control a reference signal proportional to the desired speed can be fed into the error amplifier's non-inverting input. The error amplifier output is then configured as a unity gain voltage follower by connecting its inverting input to its output. The error amplifier's output is then compared to the output of the oscillator to obtain a PWM signal proportional to the desired motor speed--unless the control loop is overridden by an overcurrent or fault condition.

For closed-loop control, one approach is to filter the MC33039's output with a low pass filter to generate a voltage proportional to motor speed and feed the resulting signal into the inverting input of the MC33035's comparator. A signal proportional to desired motor speed drives the non-inverting input, and the ratio of the input and feedback resistors R3 and R4 control gain. In this design, low pass filtering and generating the error signal are combined by using feedback capacitor, C3.

Ideally, the integrator/error amplifier should produce a ripple free output even at low motor speeds. To do so at very low speeds reduces system response time, however. Component values must be adjusted according to the rotors' load, inertia and friction. In this particular application the values 2 M ohm and 0.01 µF give good dynamic response and stability.

When motor speed is less than the desired speed, the MC33035 extends the output pulse width to the drive transistors. When motor speed is greater than the desired speed, the duty cycle decreases. However, if the input signal abruptly demands a much lower speed, the duty cycle could fall to zero and the motor would coast to desired low speed. Therefore, since the MC33035 has no provision to dynamically brake the motor and thus control rapid deceleration, it is best suited for applications which have a large frictional load or those that do not require a controlled, abrupt deceleration.

d. Braking

Dynamic braking is used. The three high-side motor drive transistors are turned off and the three low-side drive transistors are turned on, in sequence. This circulates the back Electro Magnetic Force (EMF) generated currents through the motor winding for dissipation of stored energy.

A logic high at pin 2 of the motor drive control connector calls for dynamic braking.

3-5. Speed Control

Theory of Operation

Speed control is accomplished by a 10k ohm potentiometer used in conjunction with the Motorola brushless motor control chip integrated circuit set (MC33035 and MC33039). The wiper of the potentiometer is the control input to MC33035. Lower speed is selected when the voltage on the wiper is decreased (by turning counterclockwise) and higher speed is selected when voltage on the wiper is increased (by turning clockwise).

The motor has three Hall-effect sensors internally mounted to generate pulses as the motor turns. These pulses are monitored by the MC33035 allowing the controller to change the width of the pulse sent to the motor drive to control the speed. The wider the pulse, the faster the motor runs.

The sensors are also used to generate a pulse string for the speed indicator. MC33039 generates 12 pulses for each revolution of the motor.

3-6. Timer

Theory of Operation

The timer consists of a crystal controlled oscillator and a variety of "HC" (High speed Complementary metal oxide semiconductor) logic circuitry operating on 5 Vdc. When the timer elapses to zero, the rotor motor begins to brake.

If HOLD mode is selected, the timer is disabled and the centrifuge continues to run until the operator presses the STOP switch to end the run.

3-7. Door Latching Mechanism

Theory of Operation

The door closing/locking mechanism is a latch, secured to the underside of the frame; a striker, secured to and extending through the chamber door; a latch release activated by a solenoid; a door closure sensor; and a door release button. Door open/close position is monitored by a magnetic switch.

The circuitry that controls the door latch solenoid is on the Control Printed Circuit Board. When the door open switch is closed, the solenoid is energized for less than one second no matter how long the switch is held. It consists of logic gate controls and solenoid driver circuits. The logic controlling the door release solenoid must meet all of the following conditions before the door open switch will operate:

- door closed
- timer not active
- low speed (less than 90 rpm).

The Latch solenoid cannot be energized when rotor speed is more than 62 rpm.

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Section 4. Printed Circuit Boards and Schematics

Figures

Tables

Section 4: PRINTED CIRCUIT BOARDS and SCHEMATIC DIAGRAMS

This section contains a system wiring diagram as well as schematic diagrams and component description tables for printed circuit boards found in the TC6® Tabletop Centrifuge.

VOLTAGE	FUSES	JUMPERS
100V-120V	3.15A	1 TO 4 & 3 TO 6
220V-240V	2.0A	3 TO 4

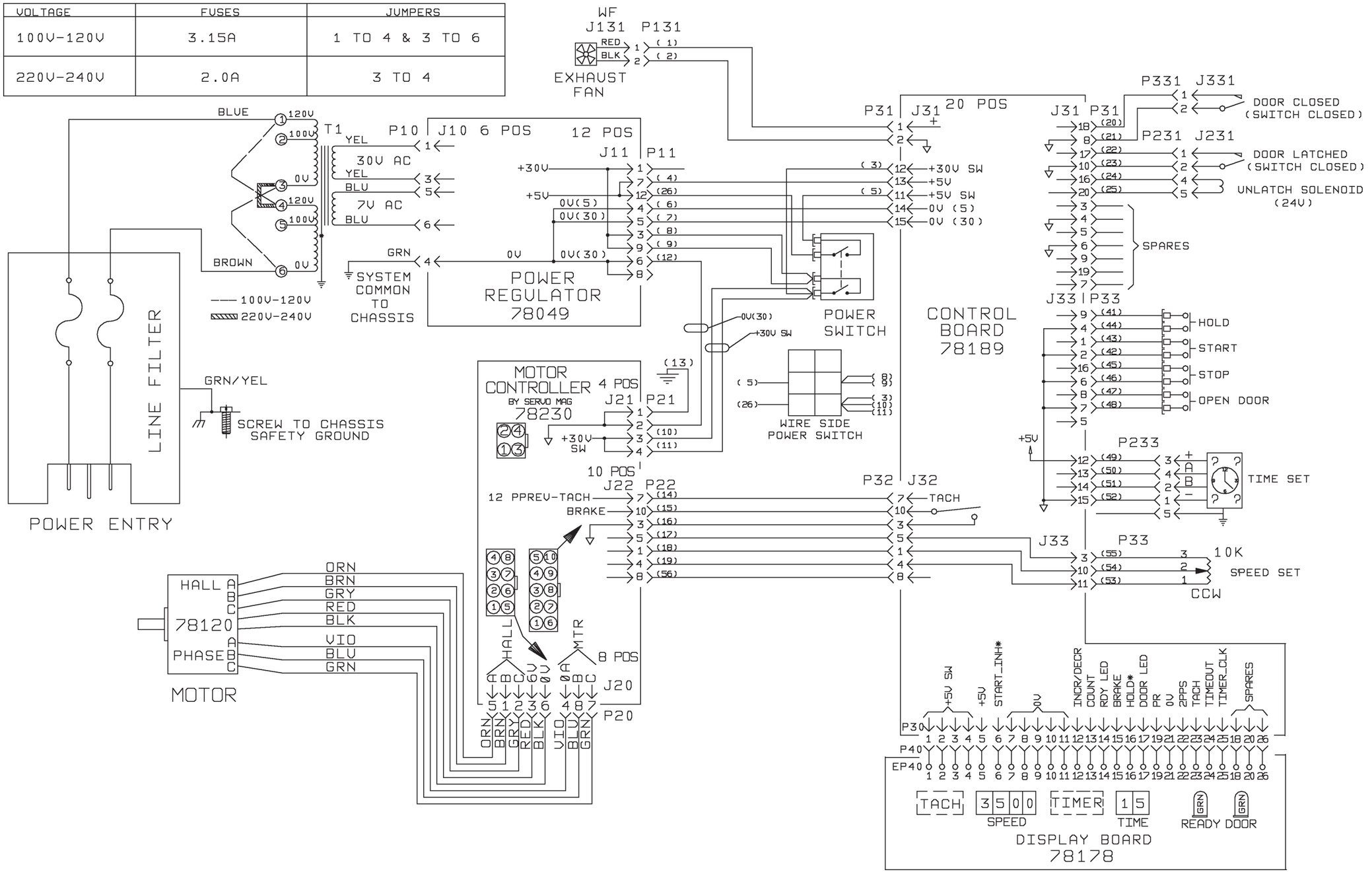


Figure 4-1. System Wiring Diagram,
(SN 9501734 and above)
(SN 9600946 and above, 60 Hz only, Do Not Use Line Filter)

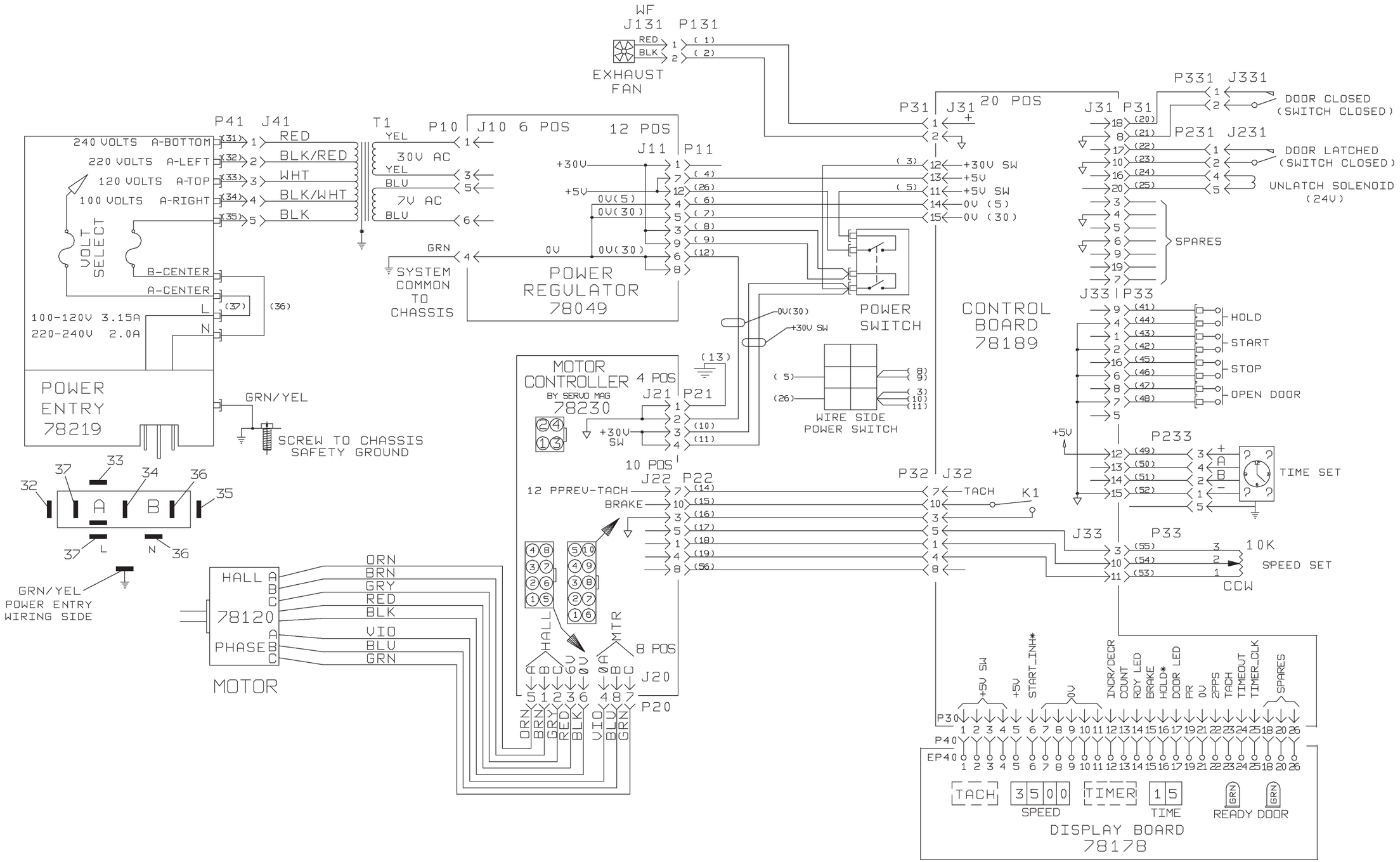
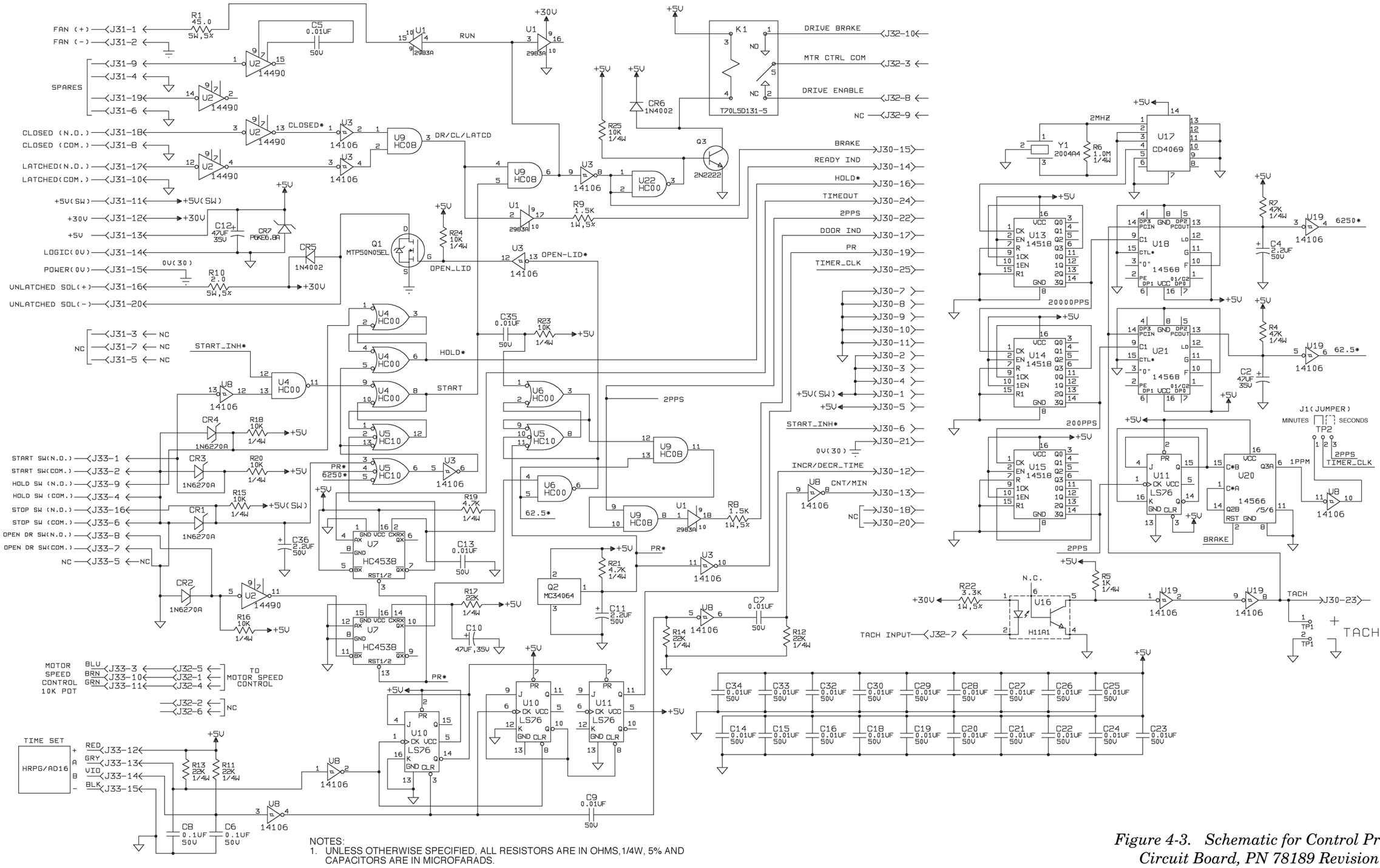


Figure 4-2. System Wiring Diagram, (SN 9501733 and below)



NOTES:
1. UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS,1/4W, 5% AND CAPACITORS ARE IN MICROFARADS.

Figure 4-3. Schematic for Control Printed Circuit Board, PN 78189 Revision 3

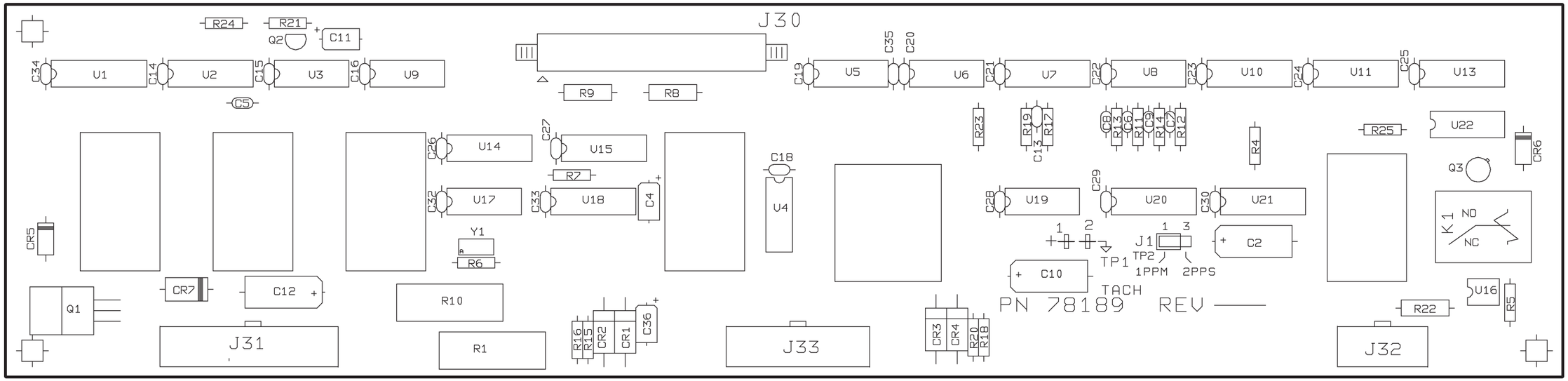


Figure 4-4. Control Printed Circuit Board Assembly, PN 78189 Revision 3

Table 4-1. Component Description, Control Printed Circuit Board, PN 78189 Revison 3

(refer to figure 4-4)

Component	Description
R5	Resistor, 1.0 KΩ, 1/4W, 5%, Carbon Comp.
R15, R16, R18, R20, R23, R24, R25	Resistor, 10 KΩ, 1/4W, 5%, Carbon Comp.
R6	Resistor, 1.0 MΩ, 1/4W, 5%, Carbon Comp.
R8, R9	Resistor, 1.5 KΩ, 1/4W, 5%, Carbon Comp.
R10	Resistor, 2 KΩ, 5W, 5%, Wirewound
R11, R12, R13, R14, R17	Resistor, 22 KΩ, 1/4W, 5%, Carbon Comp.
R22	Resistor, 3.3 KΩ, 1W, 5%, Carbon Comp.
R19, R21	Resistor, 4.7 KΩ, 1/4W, 5%, Carbon Comp.
R4, R7	Resistor, 47 KΩ, 1/4W, 5%, Carbon Comp.
R1	Resistor, 75Ω, 15W, 5%, Carbon Comp.
C5, C7, C9, C13, C14, C15, C16, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C32, C33, C34, C35	Capacitor, 0.01 µF, 50V
C6, C8	Capacitor, 0.1 µF, 50V, 20%
C4, C11, C36	Capacitor, 2.2 µF, 50V, 20%
C2, C10, C12	Capacitor, 47 µF, 16V, 20%
U13, U14, U15	I.C., CMOS, Dual BCD, MC14518BP
U18, U21	I.C., CMOS, Phase Comp/Prog Cntrs, MC14568BP
U10, U11	I.C., CMOS, Dual J-K Flip Flop, MC74HC76N
U3, U8, U19	I.C., CMOS, Schmitt Trigger, MC14106BP
U20	I.C., CMOS, Time Base Gen., MC14566BP
U2	I.C., CMOS, Bounce Elim., MC14490P

Table 4-1. Component Description, Control Printed Circuit Board, PN 78189 Revision 3 (continued)

(refer to figure 4-4)

Component	Description
U9	I.C., CMOS, Quad AND, MC74HC08N
U5	I.C., CMOS, 3 Input NAND, MC74HC10N
U4, U6, U22	I.C., CMOS, Quad NAND, MC74HC00N
U1	I.C., Hi-Volt Source Driver, UND-2983A
U7	I.C., CMOS, Dual Multivibrator, MC74HC4538N
U16	I.C., CMOS, Opto-Isolator, H11A1
U17	I.C., CMOS, Hex Inverter, CD4069UBE
Q1	Transistor, Power N-Channel E-FET
Q2	I.C. Undervolt Sensing, MC34064P-5
Q3	Transistor, NPN Type, 2N2222
Y1	Resonator, Ceramic, 2MHz
K1	Relay, PCB Type, SPDT
CR1, CR2, CR3, CR4	Diode, Zener, IN6270A, 9.1V
CR5. CR6	Diode, Silicon, 100V/1A, IN4002/IN4002GP
CR7	Diode, Surge Type, 600W
J30	Connector, Header, 26 Position
J31	Connector, Header, 20 Position
J33	Connector, Header, 16 Position
J32	Connector, Header, 10 Position
TP2	Connector, Header, 3 Pin
J1	Plug, Interconnection, 2 Position
TP1	Test Points

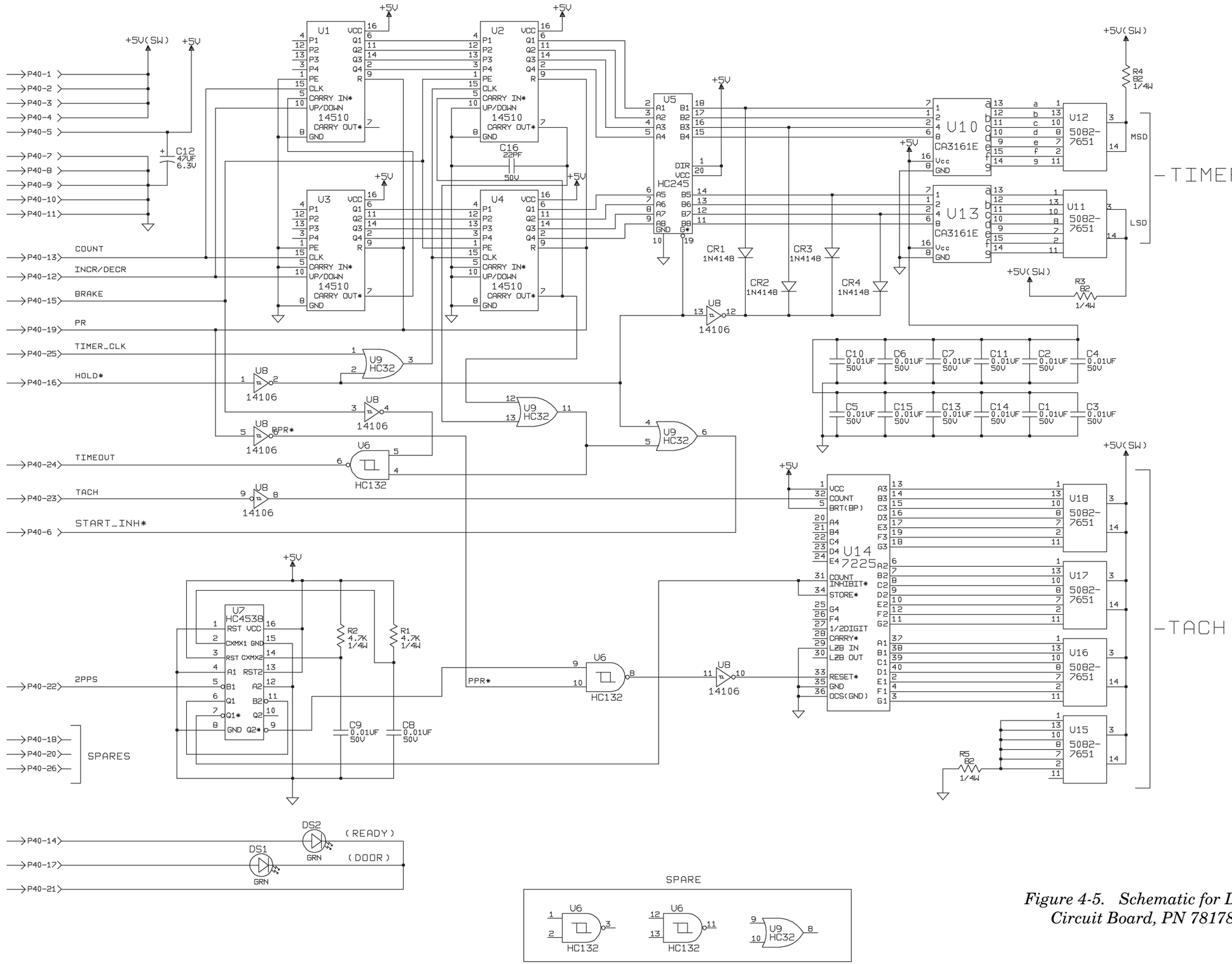


Figure 4-5. Schematic for Display Printed Circuit Board, PN 78178 Revision 4

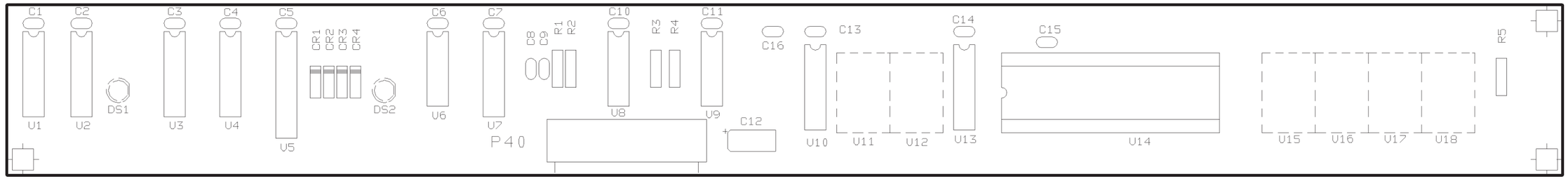


Figure 4-6. Display Printed Circuit Board Assembly, PN 78178 Revision 4

Table 4-2. Component Description, Display Printed Control Board, PN 78178 Revision 4

(refer to figure 4-6)

Component	Description
R1, R2	Resistor, 4.7 KΩ, 1/4W, 5%, Carbon Comp.
R3, R4, R5	Resistor, 82Ω, 1/4W, 5%, Carbon Comp.
C1, C2, C3,C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15	Capacitor 0.01 µF, 50V
C12	Capacitor 47 µF, 6V
DS1, DS2	LED, Green, Diffused
CR1, CR2, CR3, CR4	Diode, SI., IN914 or IN4148
U5	I.C., CMOS, Octal Bus Transceiver, 74HC245AN
U10, U13	I.C., CMOS, BCD Decoder/Driver, Harris CA3161E
U7	I.C., CMOS, Dual Multivibrator, 74HC4538N
U6	I.C., CMOS, Quad NAND, 74HC132AN
U9	I.C., CMOS, Quad or, 2-Input, 74HC32AN
U1, U2, U3, U4	I.C., CMOS, BCD Counter, MC14510BP
U8	I.C., CMOS, Schmitt Trigger, MC14106BCP
U11, U12, U15, U16, U17, U18	I.C., Display, 7 Segment, HP5082-7651
U14	I.C., Display, 4 1/2 Digit, Harris ICM7225IPL
C16	Capacitor, 22 µF, 50V

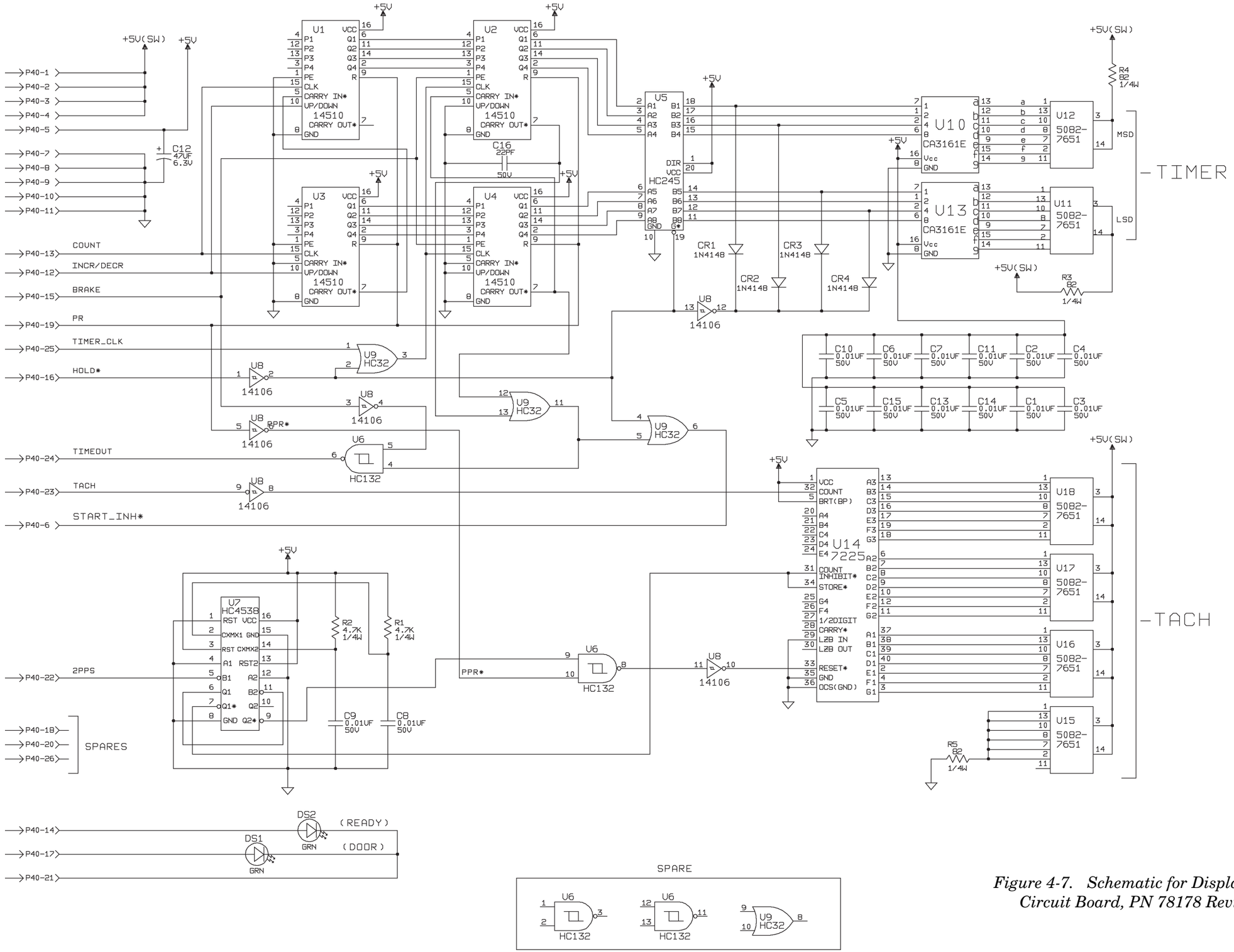


Figure 4-7. Schematic for Display Printed Circuit Board, PN 78178 Revision 2

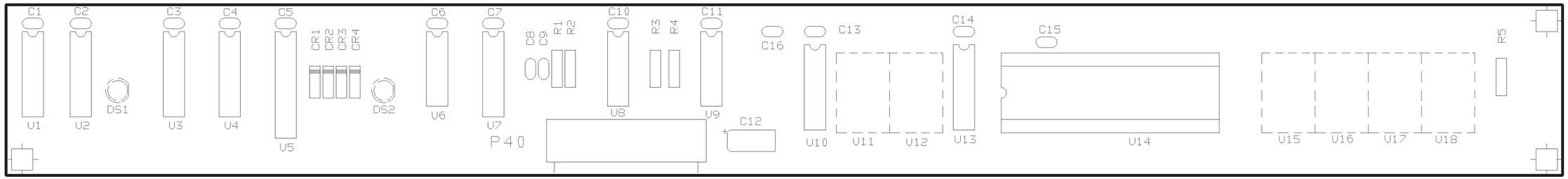


Figure 4-8. Display Printed Circuit Board Assembly, PN 78178 Revision 2

Table 4-3. Component Description, Display Printed Circuit Board, PN 78178 Revision 2

(refer to figure 4-8)

Component	Description
C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C13, C14, C15	Capacitor, 0.01 µF, 50V
C12	Capacitor, 47 µF, 6V
CR1, CR2, CR3, CR4	Diode, IN914 or IN4148
DS1, DS2	LED, Green, Diffused
R1, R2	Resistor, 4.7 KΩ, 1/4W, 5%, Carbon Comp.
R3, R4, R5	Resistor, 82 Ω, 1/4W, 5%, Carbon Comp.
U1, U2, U3, U4	I.C. CMOS, BCD Counter, MC14510BP
U5	I.C., CMOS, Octal Bustransceiver, 74HC245AN
U6	I.C., CMOS, Quad NAND, 74HC132AN
U7	I.C., CMOS, Dual Multivibrator, 74HC4538N
U8	I.C., CMOS, Schmitt Trigger, MC14106BCP
U9	I.C., CMOS, Quad or, 2-Input, 74HC32AN
U10, U13	I.C., CMOS, BCD Decoder/Driver, Harris CA3161E
U11, U12, U15, U16, U17, U18	I.C., Display, 7 Segment, HP5082-7651
U14	I.C., Display, 4 1/2 Digit, Harris ICM7225IPL

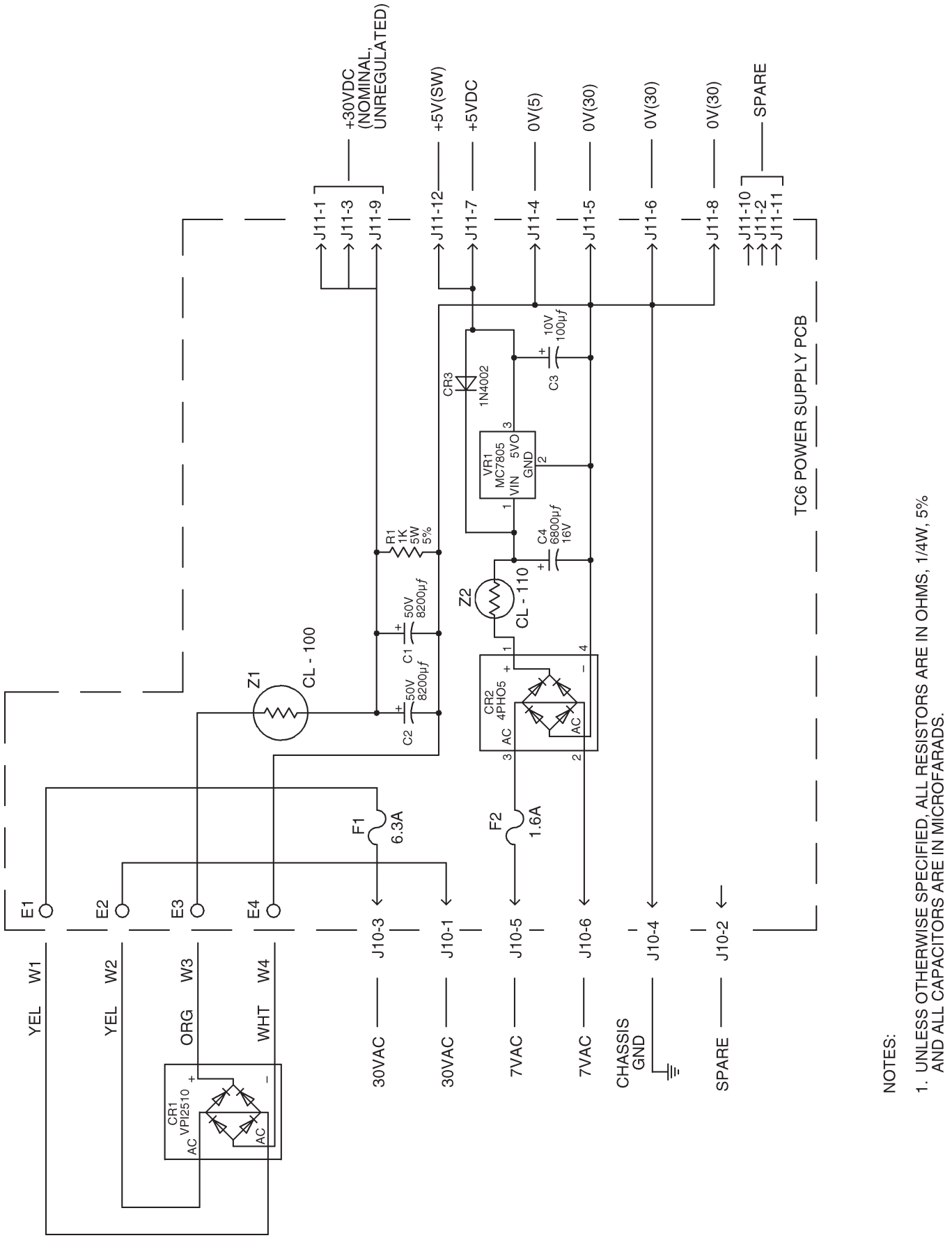


Figure 4-9. Schematic for Power Supply Printed Circuit Board, PN 78049 Revision 4

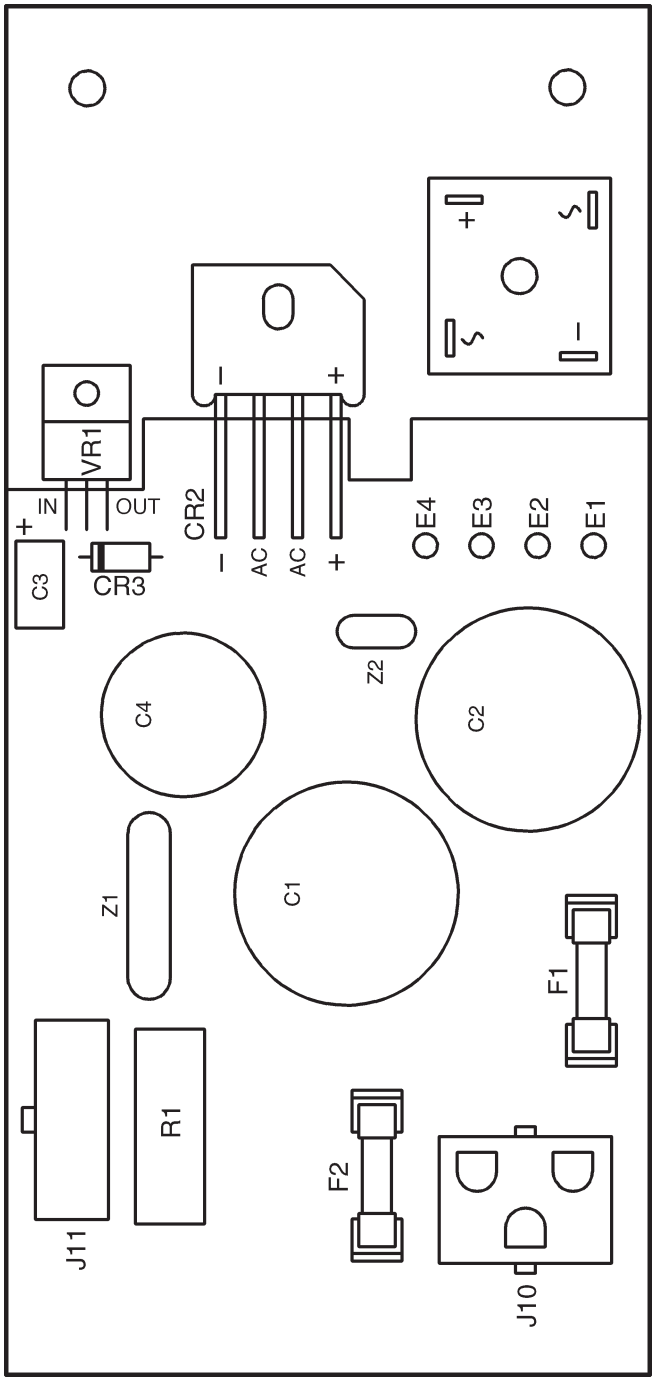


Figure 4-10. Power Supply Printed Circuit Board Assembly, PN 78049 Revision 4

Table 4-4. Component Description, Power Supply Printed Circuit Board, PN 78049 Revision 4

(refer to figure 4-10)

Component	Description
R1	Resistor, 1000 Ohm, 5W, 5%, Wirewound
C3	Capacitor, 100 µF, 10V
C4	Capacitor, 6800 µF, 16V
C1, C2	Capacitor, 8200 µF, 50V
CR3	Diode, SI, 100V, 1A, IN4002/IN4002GP
CR2	Rectifier, Bridge, 100V, 4A, KBU4B
CR1	Rectifier, Bridge, 100V, 1W, KBPC2501/W
VR1	Regulator, Pos 5V, 3 Term., LM340T-5.0
J11	Connector, Header, 12-Position
J10	Connector, Header, 6-Position
F1	Fuse, 6.3A, 250V, Littlefuse 21706.3
F2	Fuse, 1.6A, 250 V, Littlefuse 21701.6
Z2	Limiter, Current Inrush, 10 Ohm @ 25 C, Keystone CL-110
Z1	Limiter, Current Inrush, 0.5 Ohm @ 25 C, Keystone CL-100

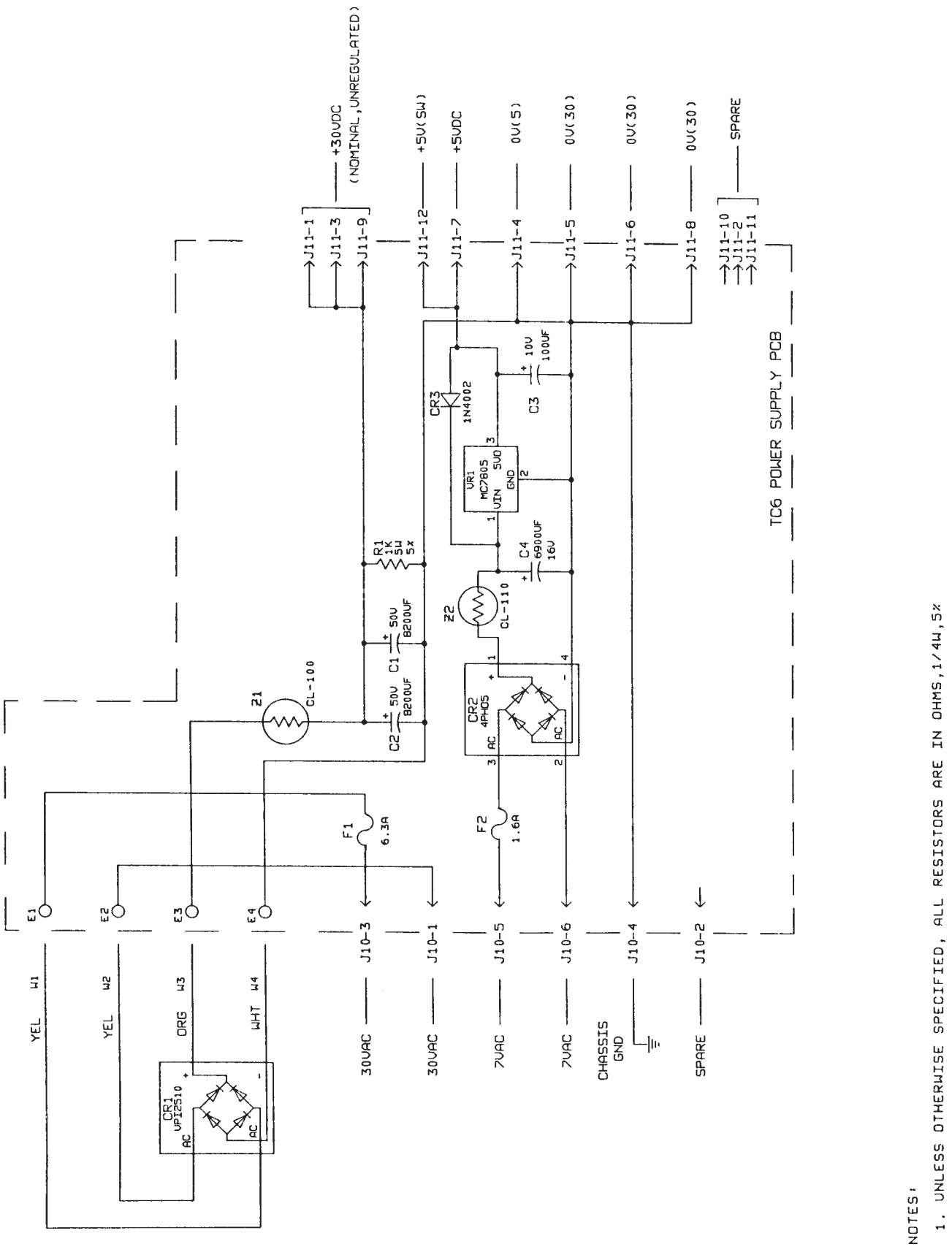


Figure 4-11. Schematic for Power Supply Printed Circuit Board, PN 78049 Revision 2

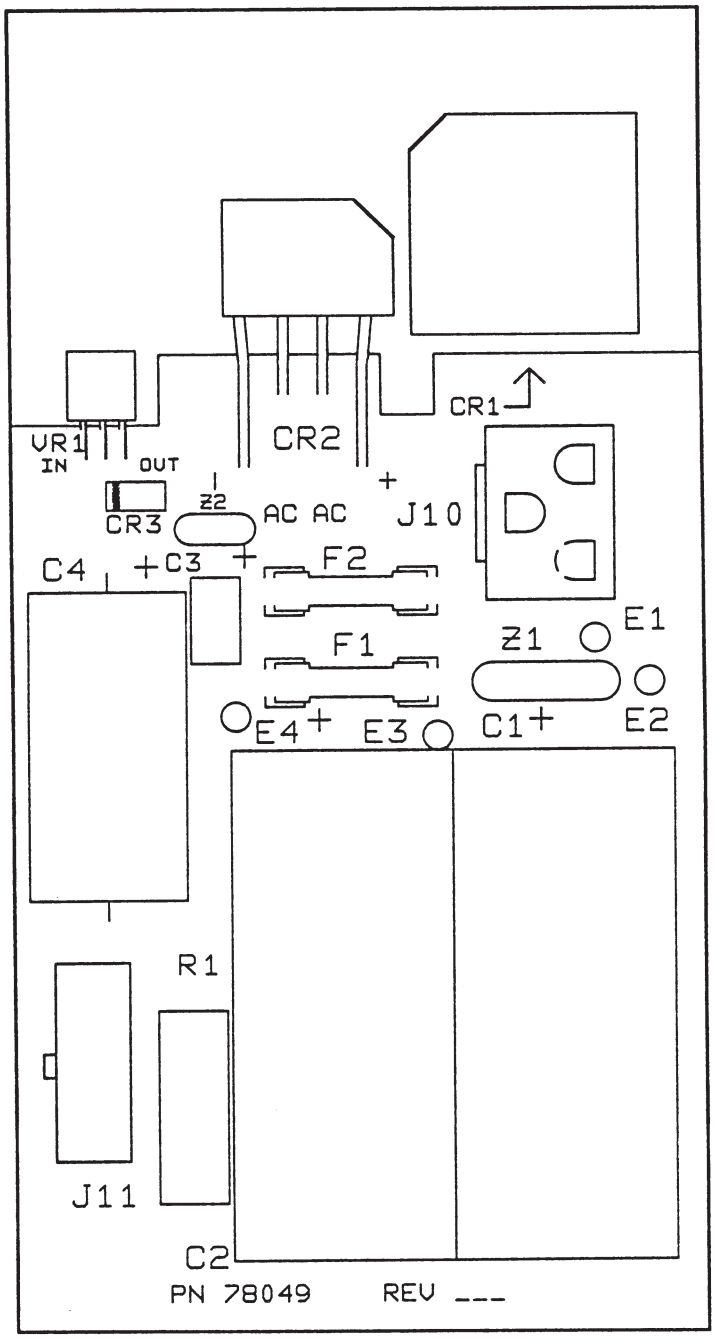


Figure 4-12. Power Supply Printed Circuit Board, PN 78049 Revision 2

Table 4-5. Component Description, Power Supply Printed Circuit Board, PN 78049 Revision 2

(refer to figure 4-12)

Component	Description
C1, C2	Capacitor, 8200 µF, 50V, Aluminum
C3	Capacitor, 100 µF, 10V, Aluminum
C4	Capacitor, 6900 µF, 16V, Aluminum
CR1	Rectifier, Bridge, 100V/1W
CR2	Rectifier, Bridge, 100V/4A
CR3	Diode, Silicon, 100V, 1A, IN4002 or IN4002GP
F1	Fuse, 6.3A, 250V, Fast Acting, 5 x 20 mm (Sorvall PN 91398; Little PN 21706.3)
F2	Fuse, 1.6A, 250V, Fast-Acting, 5 x 20 mm (Sorvall PN 91397; Little PN 21701.6)
J10	Connector, Header, 6 Position
J11	Connector, Header, 12 Position
R1	Resistor, 1000 Ω, 5W, 5%, Wirewound
VR1	Regulator, Positive 5V, 3 Terminal, LM340T-5.0
Z1	Limiter, Current Inrush, 0.5 Ω
Z2	Limiter, Current Inrush, 10 Ω

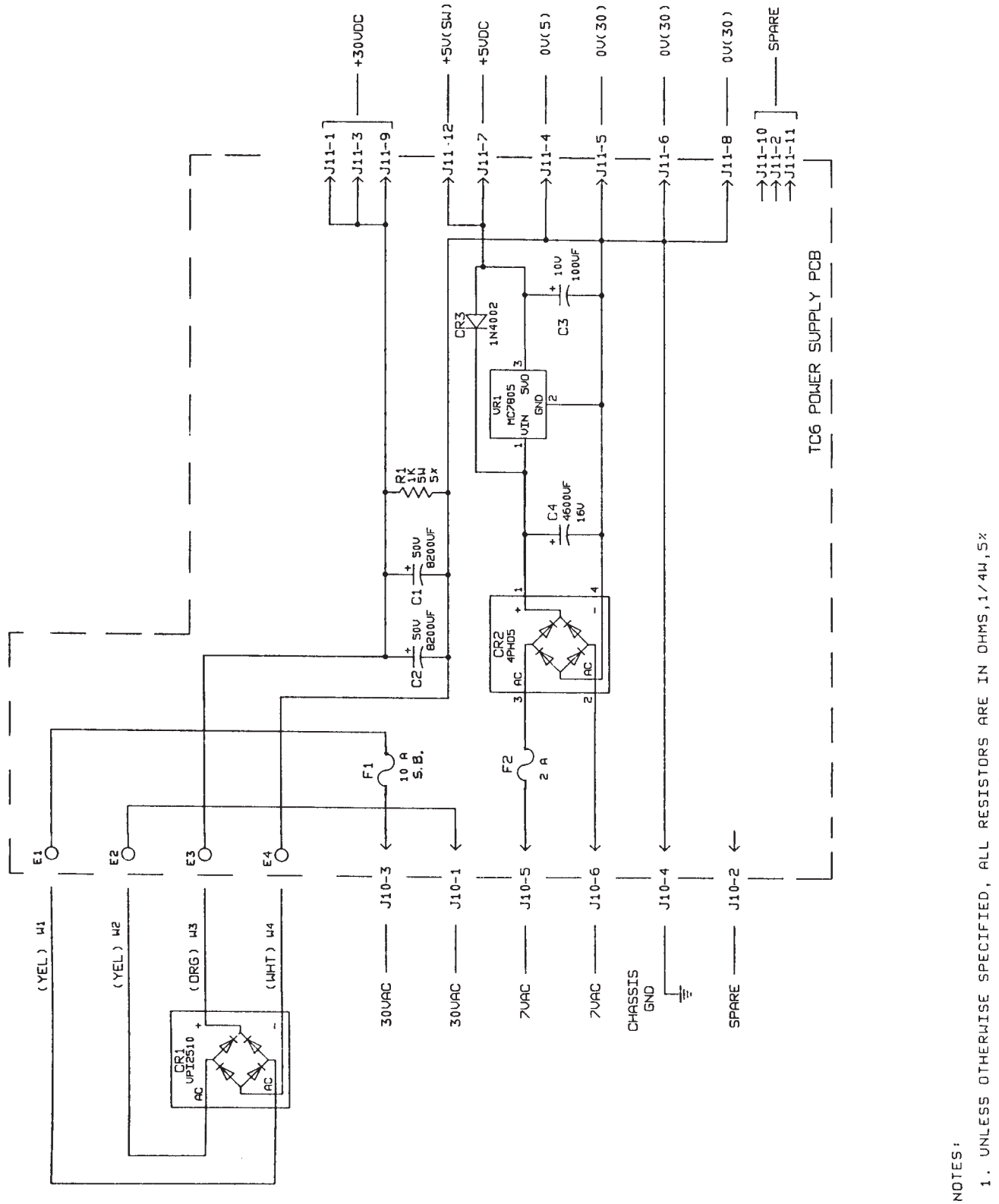


Figure 4-13. Schematic for Power Supply Printed Circuit Board , PN 78049 Revision 1

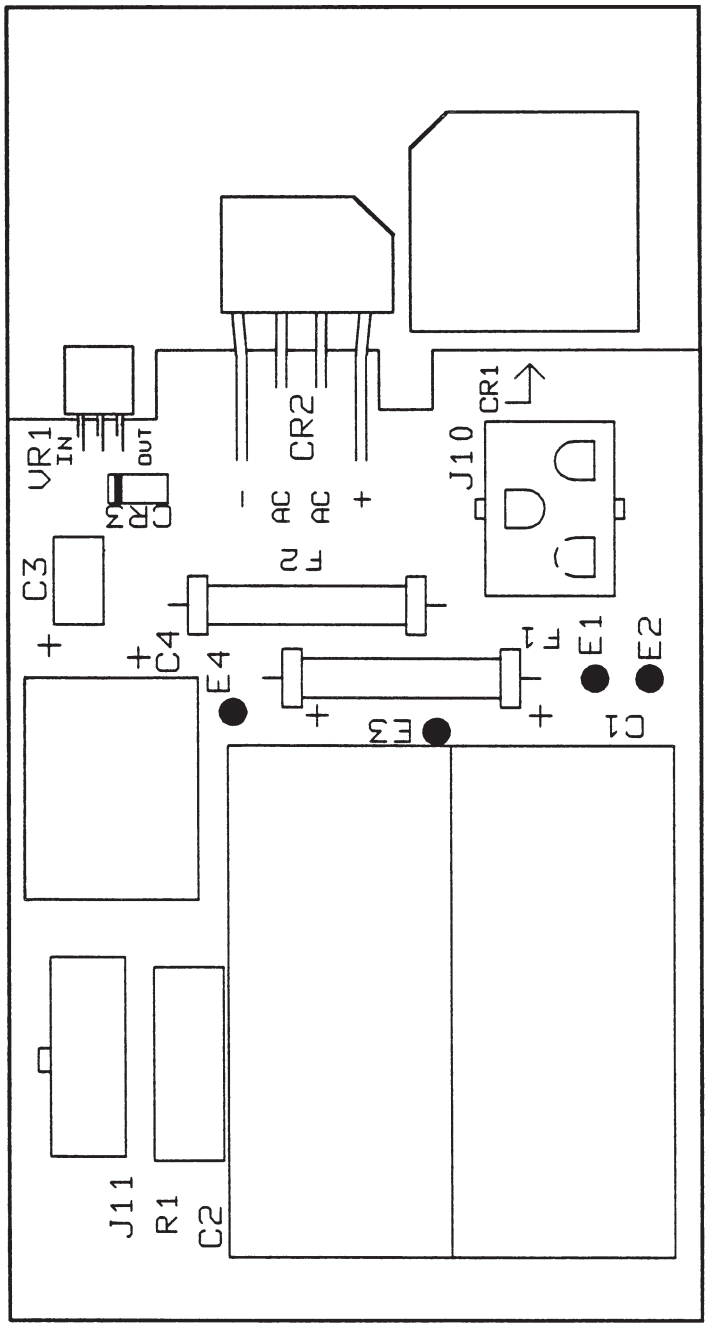


Figure 4-14. Power Supply Printed Circuit Board Assembly, PN 78049 Revision 1

Table 4-6. Component Description, Power Supply Printed Circuit Board, PN 78049 Revision 1

(refer to figure 4-14)

Component	Description
C1, C2	Capacitor, 8200 µF, 50V, Aluminum
C3	Capacitor, 100 µF, 10V, Aluminum
C4	Capacitor, 4600 µF, 16V, Aluminum
CR1	Rectifier, Bridge, 100V/1W
CR2	Rectifier, Bridge, 100V/4A
CR3	Diode, Silicon, 100V, 1A, IN4002 or IN4002GP
F1	Fuse, 10A, 250V, Slow Blow, Axial
F2	Fuse, 2A, 250V, Fast-Acting, Axial
J10	Connector, Header, 6 Position
J11	Connector, Header, 12 Position
R1	Resistor, 1000 Ω, 5W, 5%, Wirewound
VR1	Regulator, Positive 5V, 3 Terminal, LM340T-5.0

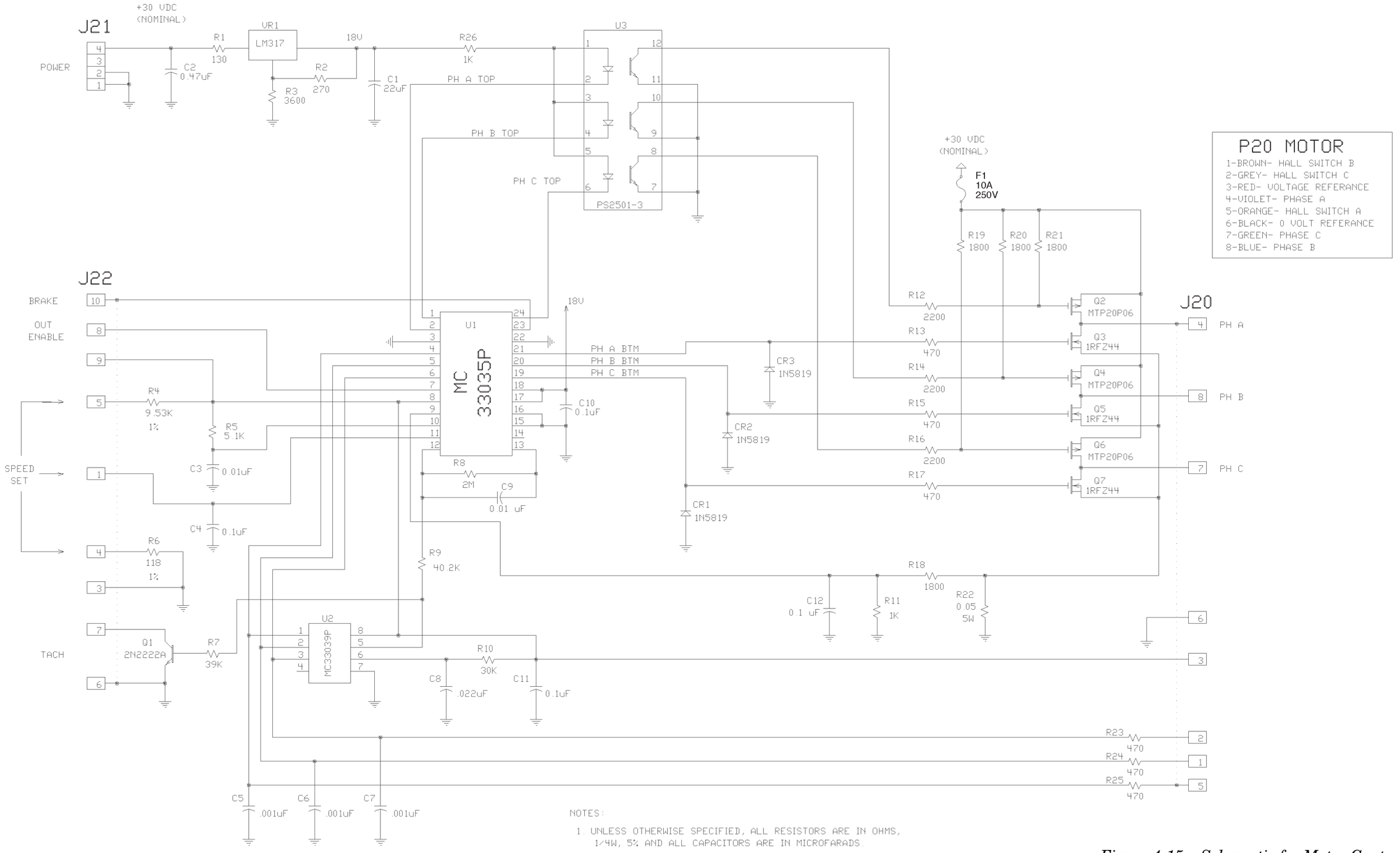


Figure 4-15. Schematic for Motor Control Printed Circuit Board Assembly, PN 78230 Revision 4

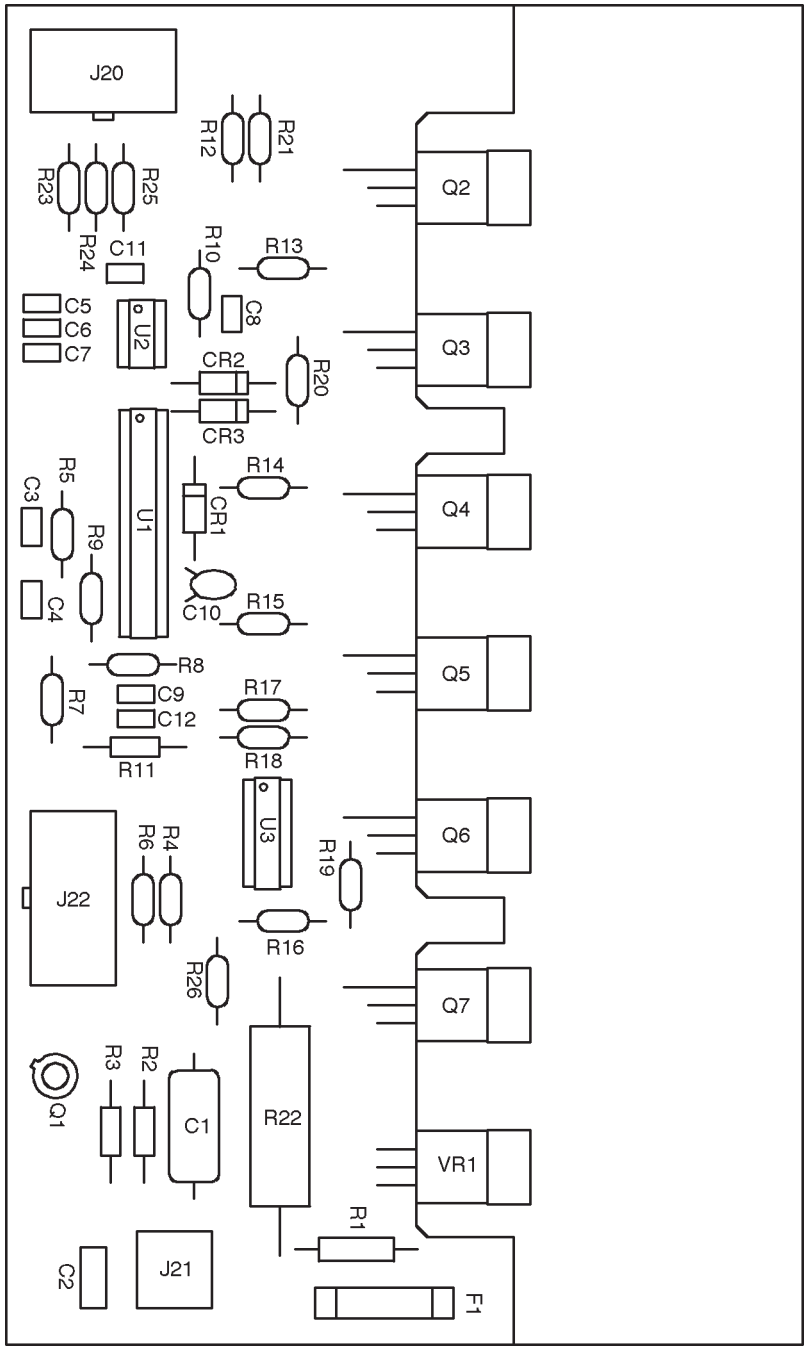


Figure 4-16. Motor Control Printed Circuit Board Assembly, PN 78230 Revision 4

Table 4-7. Component Description, Motor Control Printed Circuit Board, PN 78230 Revision 4

(refer to figure 4-16)

Component	Description
R1	Resistor, 130 Ω, 1/4W, 5%, Carbon Comp.
R2	Resistor, 270 Ω, 1/4W, 5%, Carbon Comp.
R3	Resistor, 3600 Ω, 1/4W, 5%, Carbon Comp.
R4	Resistor, 9.53 KΩ, 1/4W, 1%, CarbonFilm
R5	Resistor, 5100 Ω, 1/4W, 5%, Carbon Comp.
R6	Resistor, 118 Ω, 1/4W, 1%, Carbon Film
R7	Resistor, 39 KΩ, 1/4W, 5%, Carbon Comp.
R8	Resistor, 2 MΩ, 1/4W, 5%, Carbon Comp.
R9	Resistor, 40.2 KΩ, 1/4W, 1%, Carbon Film
R10	Resistor, 30 KΩ, 1/4W, 5%, Carbon Comp.
R11, R26	Resistor, 1000 Ω, 1/4W, 5%, Carbon Comp.
R13, R15, R17, R23, R24, R25	Resistor, 470 Ω, 1/4W, 5%, Carbon Comp.
R12, R14, R16	Resistor, 2200 Ω, 1/4W, 5%, Carbon Comp.
R18, R19, R20, R21	Resistor, 1800 Ω, 1/4W, 5%, Carbon Comp.
R22	Resistor, 0.05 KΩ, 5W, 5%, Wirewound
CR1, CR2, CR3	Diode, Rectifier, IN5819, 40V, 1A
Q1	Transistor, NPN Type, 2N2222A
Q2, Q4, Q6	Transistor, Power Mosfet, P-Channel, MTP20P06
Q3, Q5, Q7	Transistor, Power Mosfet, P-Channel, IRFZ44
VR1	Regulator, Variable, LM317
C1	Capacitor, 22 µF, 50V

Table 4-7. Component Description, Motor Control Printed Circuit Board, PN 78230 Revision 4 (continued)

(refer to figure 4-16)

Component	Description
C2	Capacitor, 0.47 µF, 50V
C3, C9	Capacitor, 0.01 µF, 50V
C4, C10, C11, C12	Capacitor, 0.1 µF, 50V
C5, C6, C7	Capacitor, 0.001 µF, 25V
C8	Capacitor, 0.022 µF, 25V
U1	I.C., Brushless DC Motor Controller, MC33035P
U2	I.C., Closed-Loop Brushless Motor Adapter, MC33039P
U3	I.C., Photo Coupler, Multichannel, NEC PS 2501-3
—	Heatsink, Mounting Plate, Aluminum, Anodized, .375 Thick
J20	Connector, 8 Position
J21	Connector, 4 Position
J22	Connector, 10 Position
F1	Fuse, 250V, 10A

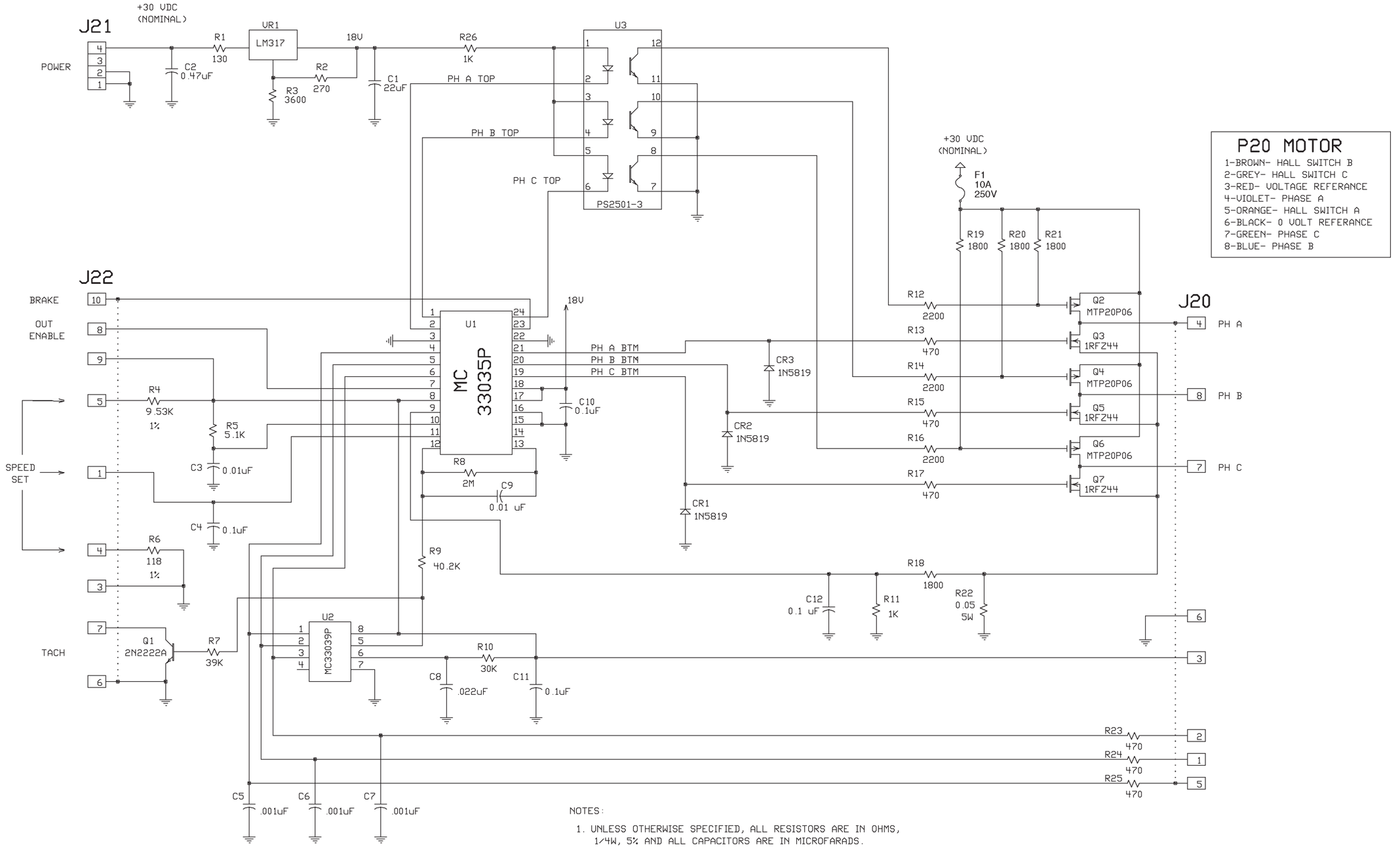


Figure 4-17. Schematic for Motor Control Printed Circuit Board, PN 78230 Revision 4

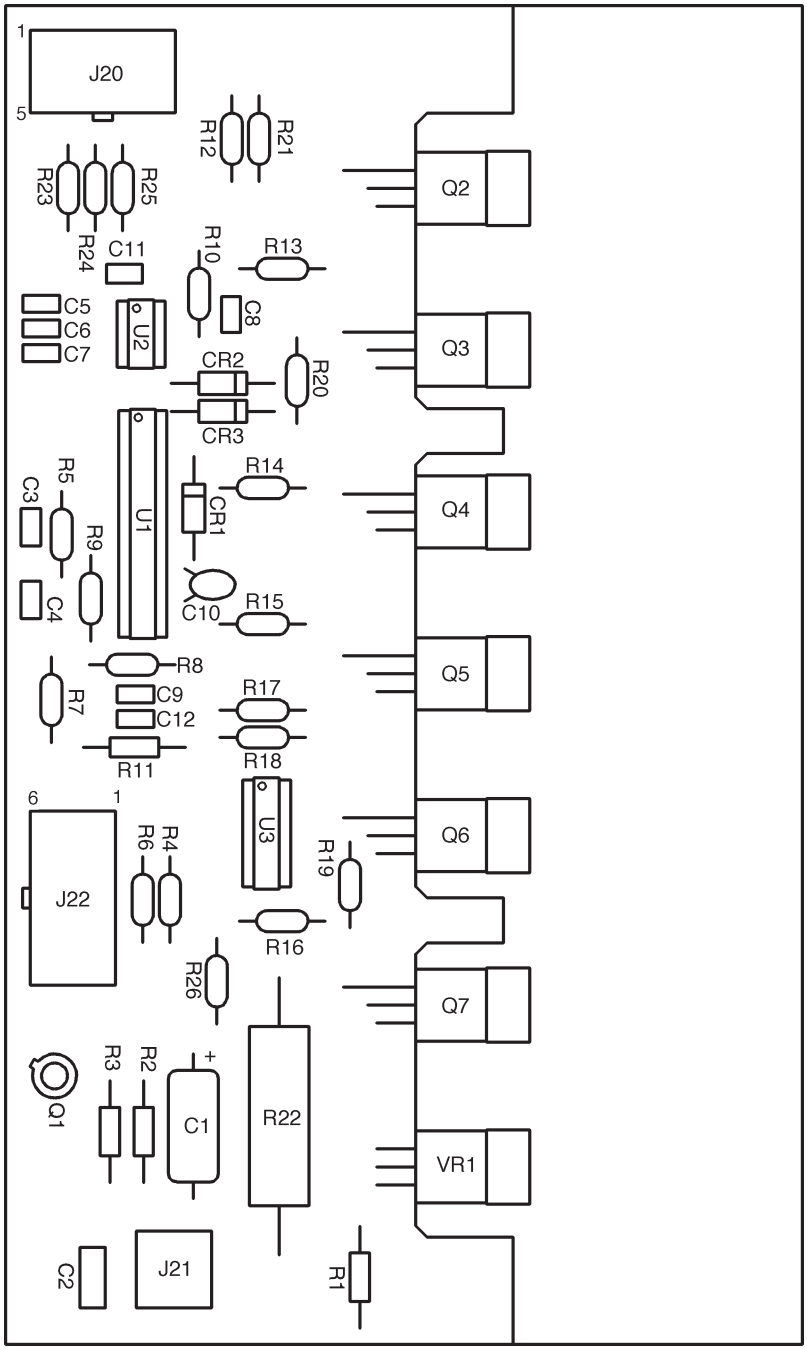


Figure 4-18. Motor Control Printed Circuit Board Assembly, PN 78230 Revision 4

Table 4-8. Component Description, Motor Control Printed Circuit Board, PN 78230 Revision 4

(refer to figure 4-18)

Component	Description
C1	Capacitor, 22 µF, 50V
C2	Capacitor, 0.47 µF, 50V
C3, C9	Capacitor, 0.01 µF, 50V
C4, C10, C11, C12	Capacitor, 0.1 µF, 50V
C5, C6, C7	Capacitor, 0.001 µF, 25V
C8	Capacitor, 0.022 µF, 25V
CR1, CR2, CR3	Diode, Rectifier, IN5819, 40V, 1A
J20	Connector, 8 Position
J21	Connector, 4 Position
J22	Connector, 10 Position
Q1	Transistor, NPN Type, 2N2222A
Q2, Q4, Q6	Transistor, Power Mosfet, P-Channel
Q3, Q5, Q7	Transistor, Power Mosfet, N-Channel
R1	Resistor, 130 Ω, 1/4W, 5%, Carbon Comp.
R2	Resistor, 270 Ω, 1/4W, 5%, Carbon Comp.
R3	Resistor, 3.6 KΩ, 1/4W, 5%, Carbon Comp.
R4	Resistor, 9.53 KΩ, 1/4W, 1%, Carbon Film
R5	Resistor, 5.1 KΩ, 1/4W, 5%, Carbon Comp.
R6	Resistor, 118 Ω, 1/4W, 1%, Carbon Film
R7	Resistor, 39 KΩ, 1/4W, 5%, Carbon Comp.
R8	Resistor, 2 MΩ, 1/4W, 5%, Carbon Comp.

Table 4-8. Component Description, Motor Control Printed Circuit Board, PN 78230 Revision 4 (continued)

(refer to figure 4-18)

Component	Description
R9	Resistor, 40.2 KΩ, 1/4W, 1%, Carbon Film
R10	Resistor, 30 KΩ, 1/4W, 5%, Carbon Comp.
R11, R26	Resistor, 1 KΩ, 1/4W, 5%, Carbon Comp.
R12, R14, R16	Resistor, 2.2 KΩ, 1/4W, 5%, Carbon Comp.
R13, R15, R17, R23, R24, R25	Resistor, 470 Ω, 1/4W, 5%, Carbon Comp.
R18	Resistor, 1.8 KΩ, 1/4W, 5%, Carbon Comp.
R19, R20, R21	Resistor, 1.8 KΩ, 1/4W, 5%, Carbon Comp.
R22	Resistor, 0.05 Ω, 1/4W, 5%, Wirewound
U1	I.C., Brushless DC Motor Contoller, MC33035P
U2	I.C., Closed-Loop Brushless Motor Adapter
U3	I.C., Photocoupler, Multi-channel
VR1	Regulator, Variable, LM317
—	Heatsink, Mounting Plate, Alumium, 0.375 thick

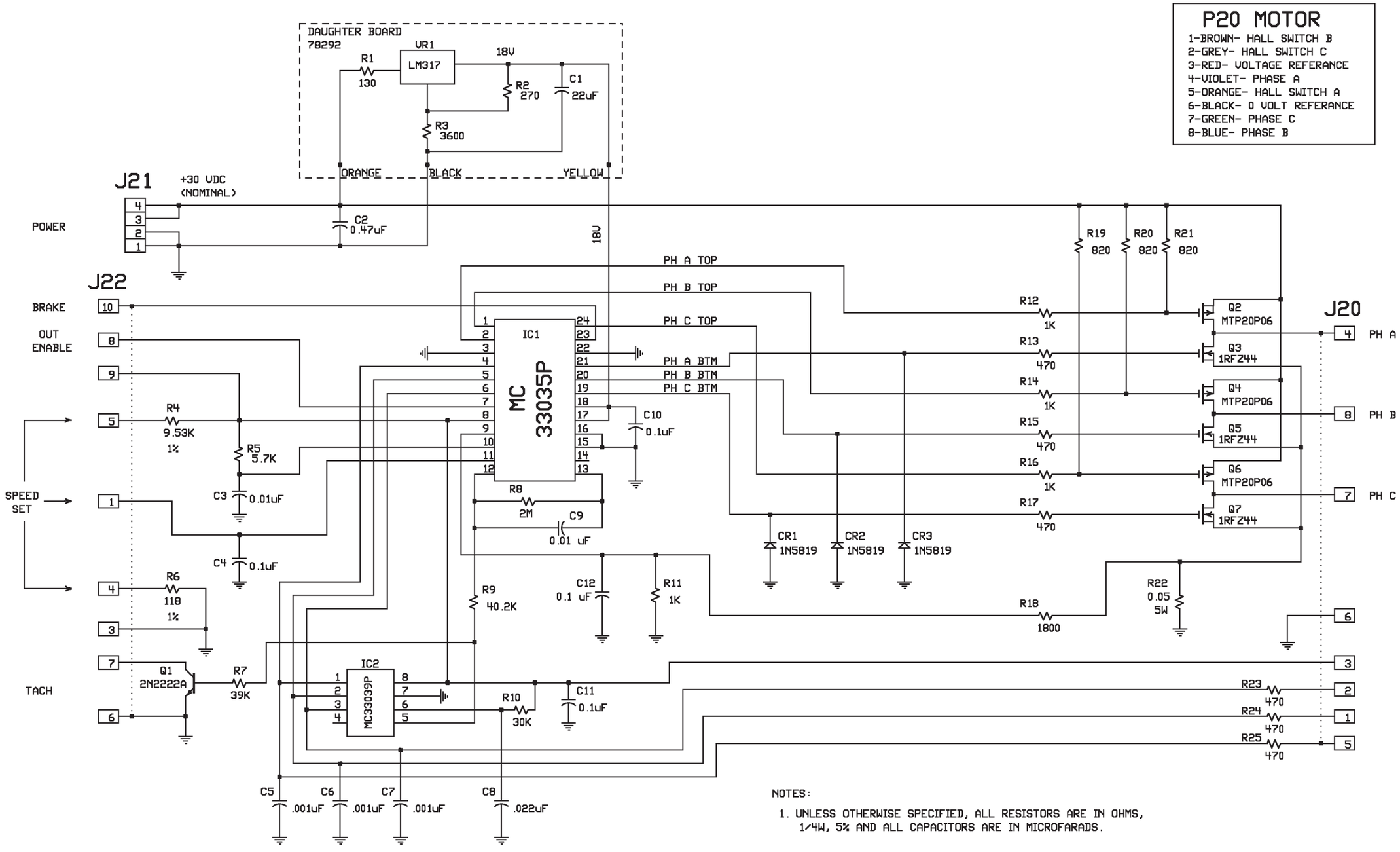


Figure 4-19. Schematic for Motor Control Printed Circuit Board, PN 78230 Revision 0

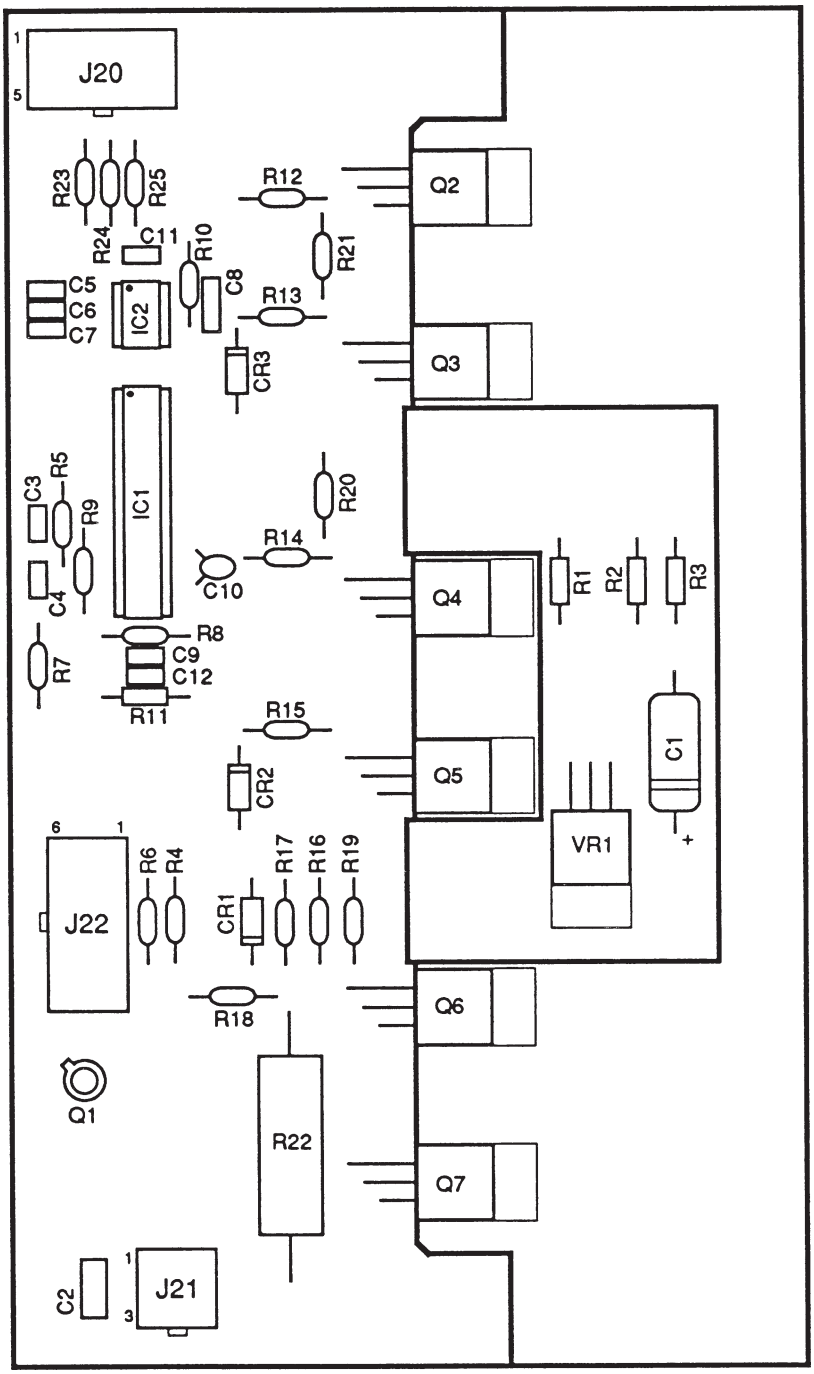


Figure 4-20. Motor Control Printed Circuit Board Assembly, PN 78230 Revision 0

Table 4-9. Component Description, Motor Control Printed Circuit Board, PN 78230 Revision 0

(refer to figure 4-20)

Component	Description
C1	Capacitor, 22 µF, 50V
C2	Capacitor, 0.47 µF, 50V
C3, C9	Capacitor, 0.01 µF, 50V
C4, C10, C11, C12	Capacitor, 0.1 µF, 50V
C5, C6, C7	Capacitor, 0.001 µF, 25V
C8	Capacitor, 0.022 µF, 25V
CR1, CR2, CR3	Diode, Rectifier, IN5819, 40V, 1A
IC1	I.C., Brushless DC Motor Contoller, MC33035P
IC2	I.C., Closed-Loop Brushless Motor Adapter
J20	Connector, 8 Position
J21	Connector, 4 Position
J22	Connector, 12 Position
Q1	Transistor, NPN Type, 2N2222A
Q2, Q4, Q6	Transistor, Power Mosfet, P-Channel
Q3, Q5, Q7	Transistor, Power Mosfet, N-Channel
R1	Resistor, 130 Ω, 1/4W, 5%, Carbon Comp.
R2	Resistor, 270 Ω, 1/4W, 5%, Carbon Comp.
R3	Resistor, 3.6 KΩ, 1/4W, 5%, Carbon Comp.
R4	Resistor, 9.53 KΩ, 1/4W, 1%, Carbon Film
R5	Resistor, 5.7 KΩ, 1/4W, 5%, Carbon Comp.
R6	Resistor, 118 Ω, 1/4W, 1%, Carbon Film

Table 4-9. Component Description, Motor Control Printed Circuit Board, PN 78230 Revision 0 (continued)

(refer to figure 4-20)

Component	Description
R7	Resistor, 39 KΩ, 1/4W, 5%, Carbon Comp.
R8	Resistor, 2 MΩ, 1/4W, 5%, Carbon Comp.
R9	Resistor, 40.2 KΩ, 1/4W, 1%, Carbon Film
R10	Resistor, 30 KΩ, 1/4W, 5%, Carbon Comp.
R11, R12, R14, R16	Resistor, 1 KΩ, 1/4W, 5%, Carbon Comp.
R13, R15, R17, R23, R24, R25	Resistor, 470 Ω, 1/4W, 5%, Carbon Comp.
R18	Resistor, 1.8 KΩ, 1/4W, 5%, Carbon Comp.
R19, R20, R21	Resistor, 820 Ω, 1/4W, 5%, Carbon Comp.
R22	Resistor, 0.05 Ω, 1/4W, 5%, Wirewound
VR1	Regulator, Variable, LM317
—	Heatsink, Mounting Plate, Alumium, 0.375 thick

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Section 5: REPAIR and REPLACEMENT

This section contains repair and replacement procedures for the TC6® Tabletop Centrifuge. If service beyond the scope of this manual is necessary, contact the nearest district office or local Field Service Engineer for SORVALL® Centrifuges.

WARNING

Because of the high voltages in the centrifuge, untrained personnel must not attempt any repair or replacement procedures. To reduce the potential of electrical shock unplug the centrifuge power cord before proceeding unless otherwise specified.

Be sure that user has performed appropriate decontamination procedures as outlined in paragraph 1-2, before attempting any repair or replacement procedures on the centrifuge.

5-1. Latch Replacement

NOTE Retain all hardware for reassembly unless otherwise advised.

1. Open chamber door.
2. Turn centrifuge power off and unplug power cord.
3. Remove the two phillips screws located on each side of the bezel. Carefully lift the bezel up to disengage it from the frame (but do not disconnect).
4. The latch assembly is installed on the Latch/P.C. Board panel using mounting hardware (two nuts at the top of the bracket and two phillips screws at the bottom of the bracket). Remove the latch mounting hardware - the nuts require a 7 mm wrench. Refer to figure 5-1.

NOTE **Do not** remove the two phillips screws located in the center of the latch assembly bracket — these screws secure the latching mechanism to the bracket, and *must not* be loosened.

5. Disconnect P231, then remove and discard the defective latch assembly.
6. Install new latch assembly securing it in place using the hardware removed in step 4. Before tightening the hardware, adjust the latch assembly following the procedure given in paragraph5-2.

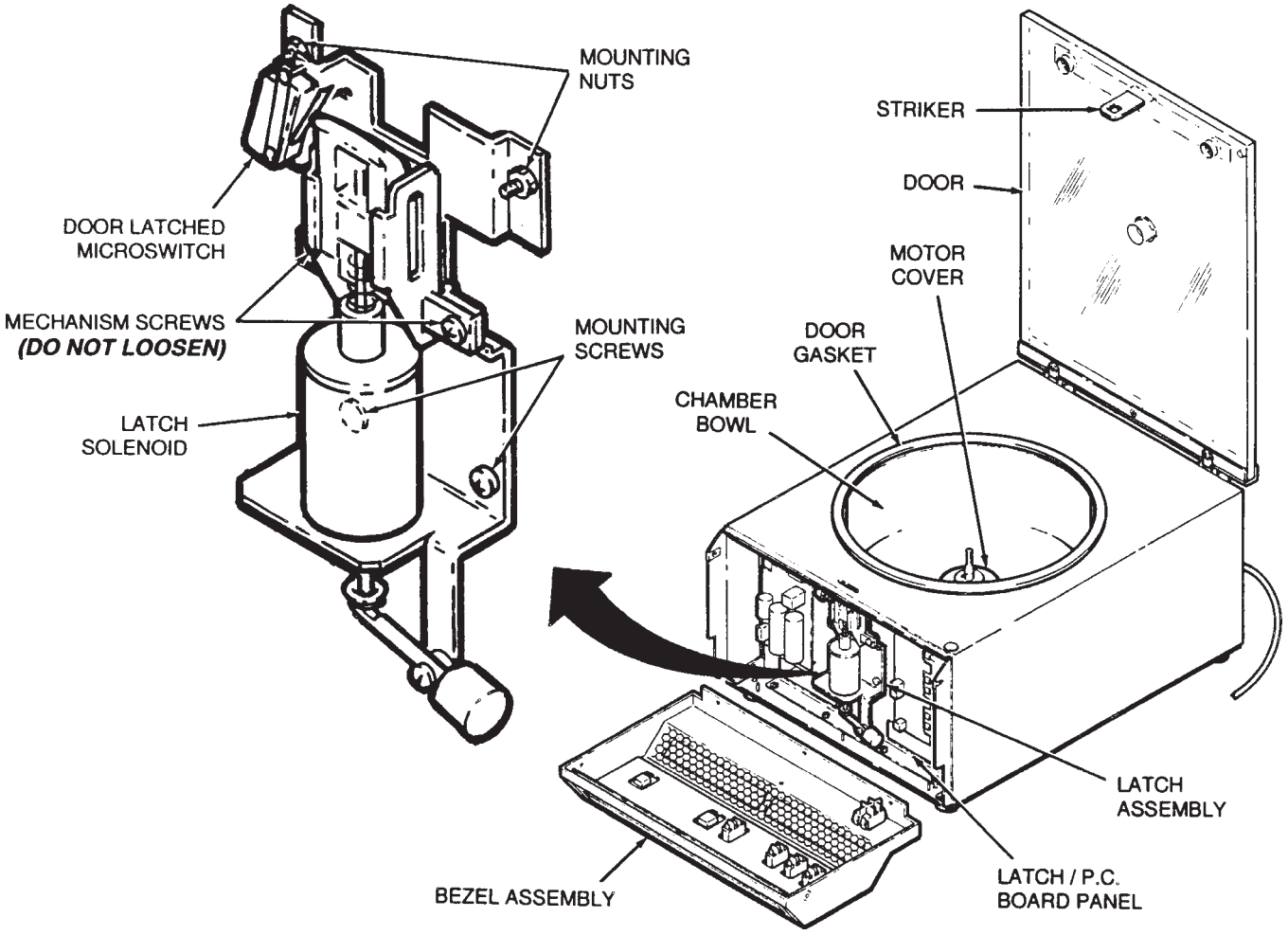

Figure 5-1. Latch Assembly

5-2. Latch Adjustment

1. Open chamber door.

2. Turn centrifuge power off and unplug power cord.

3. Remove the motor cover and the chamber bowl with door gasket from the centrifuge.

NOTE Early model TC6® Centrifuges had a ground wire connected to the underside of bowl. The ground wire is no longer required and should be permanently removed.

4. Remove two phillips head screws securing the bottom of the latch assembly bracket to the latch/P.C. board panel, then remove the two nuts securing the top of the bracket. Refer to figure 5-1.

5. Disconnect P231, then remove and discard the latch assembly.

6. Position the new latch assembly on the latch/P.C. board panel and install, but do not tighten, the hardware removed in step 4.

NOTE **Do not** loosen the two phillips head screws in center of latch assembly bracket – these screws secure the latching mechanism to the bracket, and *must not* be loosened.

7. Lower the chamber door until the striker clicks securely into the latch assembly (the plastic portion of the latching mechanism will pop up when engaged).

8. Gently lift on the front of the latched door (slotted holes in the latch assembly bracket will limit upward travel) and position two 10 mm spacers (for example, the shanks of two 10 mm screws) between the cabinet door –– one of each side, approximately two inches from the front corners.

NOTE When using spacers, care must be taken not to bear down on the door so that marks are not made on the cabinet paint or door surface.

9. Gently lower the latched door until it lightly touches the spacers, then securely tighten the latch assembly mounting hardware.

10. Pull down on the latch solenoid shaft to manually release the door.

    If the latch does not release, readjust the latch assembly, adjust the door striker, or (if the door is not parallel to the cabinet) reset the door hinges. If the latch is still unable to release the door, loosen the four nuts that secure the latch/P.C. board panel to the frame, and reset the lateral adjustment of the panel. If none of these adjustments result in the ability to manually release the door by pulling down on the latch solenoid shaft, the latch assembly or striker may need to be replaced.

11. Remove the 10 mm spacers, then adjust and secure the latch microswitch:

    a. Remove the lower mounting screw from the latch microswitch, apply Loctite® 222 to the threads, then reinstall it so that it is just snug (not tight). Do the same with the upper mounting screw, but leave it loose enough for the microswitch to pivot on the lower screw.

    b. Connect the leads of a DMM (digital multimeter) to the COM and the N.O. tabs on the microswitch and set the DMM for ohms.

    c. Close the chamber door so that the striker clicks securely into the latch assembly (the plastic portion of the latching mechanism will pop up when engaged).

WARNING

DMM configuration of the microswitch actuation is critical. If the microswitch is not properly adjusted, the centrifuge could start without the lid being latched.

d. Rotate the microswitch clockwise toward the latching mechanism until the microswitch actuator lever is pressed against the mechanism's plastic portion and the DMM registers a value. Then, without moving the microswitch, tighted the upper mounting screw.

e. Pull down on the latch solenoid shaft to release the door. The DMM should indicate open.

f. Readjust as required. When proper adjustment is achieved, tighten the lower screw, then remove the DMM and reconnect P231.

12. Reinstall the chamber bowl with door gasket and motor cover, then perform a functional check before completing reassembly:

    a. Close and latch, then manually release the chamber door several times. If the latch "drags", it may be necessary to bend the door striker slightly.

    b. Visually check the adjustment: when latched, the door should be approximately parallel to the cabinet. If not, use a 10 mm spacer to check gap and reset latch or hinges as required.

    c. The door should touch the entire gasket circumference. Check this by placing four strips of paper around the chamber (one at each of the four sides) across the chamber door gasket and cabinet. Close and latch the door. Pull outward on each strip of paper — each should be held securely and create a frictional drag as it is pulled out. If not, use a 10 mm spacer to check gap and reset latch or hinges as required. Repeat paper test, if appropriate.

    If the latch or hinges had to be adjusted, check to make sure that pulling down on the latch solenoid shaft still releases the door.

13. Set the control panel bezel in position on the centrifuge, but do not install the mounting screws – the bezel should stay in position without them.

14. Plug in the centrifuge, set the power switch to "I" (ON) and press the DOOR switch – the latch should release the door.

WARNING

Because of the high voltages in the centrifuge, unplug the centrifuge power cord before proceeding to reduce the potential of electrical shock.

- *If the latch is unable to release the door*, it may indicate that the upward pressure of the gasket against the door is too great, and latch height needs adjustment. Set the power switch to "O" (OFF), unplug the centrifuge, then adjust height:

Lift off the control panel bezel and manually release the door by pulling door on the latch solenoid shaft, then mark the position of the latch assembly on the latch/P.C. board panel. Slightly loosen the hardware securing the latch assembly and carefully

move the assembly up not more than 1 mm (0.04 inch). Re-tighten the hardware and go back to step 13 and proceed from there to see if using the DOOR switch releases the door:

– *If the latch is still unable to release the door*, check for defective solenoid, DOOR switch, wiring, or Control P.C. Board.

– *If the latch releases the door*, go back and perform the checks in step 12 to make sure the door still closes completely.

5-3. Door Latched Microswitch Adjustment

WARNING

Unless microswitch is properly adjusted, centrifuge could start without lid being latched.

1. Open chamber door.

2. Turn centrifuge power off and unplug power cord.

3. Remove two phillips head screws from the bezel. Lift off, but do not disconnect, the bezel.

4. Check to make sure microswitch is functioning properly:

   a. Disconnect P231.

   b. Connect the leads of a digital multimeter (DMM) to the COM and the N.O. tabs on the microswitch and set DMM for ohms: With the door in the latched position, the DMM should register a value; with the door open, the DMM should indicate open.

   c. If the microswitch fails either check, manually operate the microswitch lever.

   d. Replace microswitch if it fails the check.

5. With DMM connected as in step 4, adjust microswitch:

   a. Set the microswitch mounting screws so that the upper screw is loose and the lower screw is just loose enough for the microswitch to rotate.

   b. Close and latch the door (when door is latched, the plastic portion of the latching mechanism pops up).

   c. Rotate microswitch so that the lever actuator is against the latching mechanism until the DMM registers a value, then (without moving the microswitch) tighten the top screw.

   d. Pull down on the latch solenoid shaft to release the door. The DMM should indicate open.

Make incremental adjustments as required, then tighten lower screw when adjustment is complete.

5-4. Hinge Replacement

NOTE Hinges should be replaced one at a time so that the door height geometry is not disturbed.

1. Open chamber door.
2. From chamber side of door, remove the screw from one hinge.
3. Close and latch chamber door.
4. Use tape to mark the bottom and one side of the hinge from which the screw was removed.

WARNING
Hinge is spring-loaded. Take care to avoid backlash when removing screws.

5. On same side, 5 cm (2 inches) from back corner, precisely measure and record the distance (gap) from door to cabinet.
6. Remove the hinge by removing the two screws in door bracket and the four screws in cabinet.
7. Position new hinge (align with tapes). Install 2 screws to door bracket, then four screws to cabinet. Remove tapes.
8. Open chamber door and reinstall the screw removed in step 2.
9. Close and latch chamber door and check distance as in step 5. If distance is not the same as that recorded, loosen the four cabinet screws to precisely adjust. Retighten screws.
10. Repeat procedure for other hinge.

5-5. Door Closed Sensor Check

1. Check that the door magnet is in place. If not, install one.
2. Make sure the closed door sensor is properly positioned. The top of the door closed sensor should be positioned flush with the top of the cabinet (up inside the sensor cover plug).
3. Check that the closed door sensor is functioning properly:

   Unplug P/J 331. Then, connect the leads of a digital multimeter (DMM) to the sensor and set DMM for ohms: With the door magnet near the sensor, the DMM should register a value; with the door magnet away from the sensor, the DMM should indicate open. If the sensor fails either test, replace the sensor.

5-6. Door Closed Sensor Replacement

NOTE Before you replace the door closed sensor, be sure it is functioning properly by following the procedure given in paragraph 5-5. Also, check the *new* sensor before installing.

1. Turn the centrifuge power OFF and unplug the power cord.

2. Remove the two phillips screws located on each side of the bezel. Carefully lift the bezel up to disengage it from the frame (but do not disconnect wiring) and gently place the bezel so that the p.c. boards are facing up.

3. Disconnect P/J 331 (refer to figure 5-2). Loosen the back-up nut. Then, while holding the back-up nut, remove and discard the old door closed sensor threading it out through the *bottom* of the bracket.

4. Open chamber door. Remove the sensor cover plug from the cabinet.

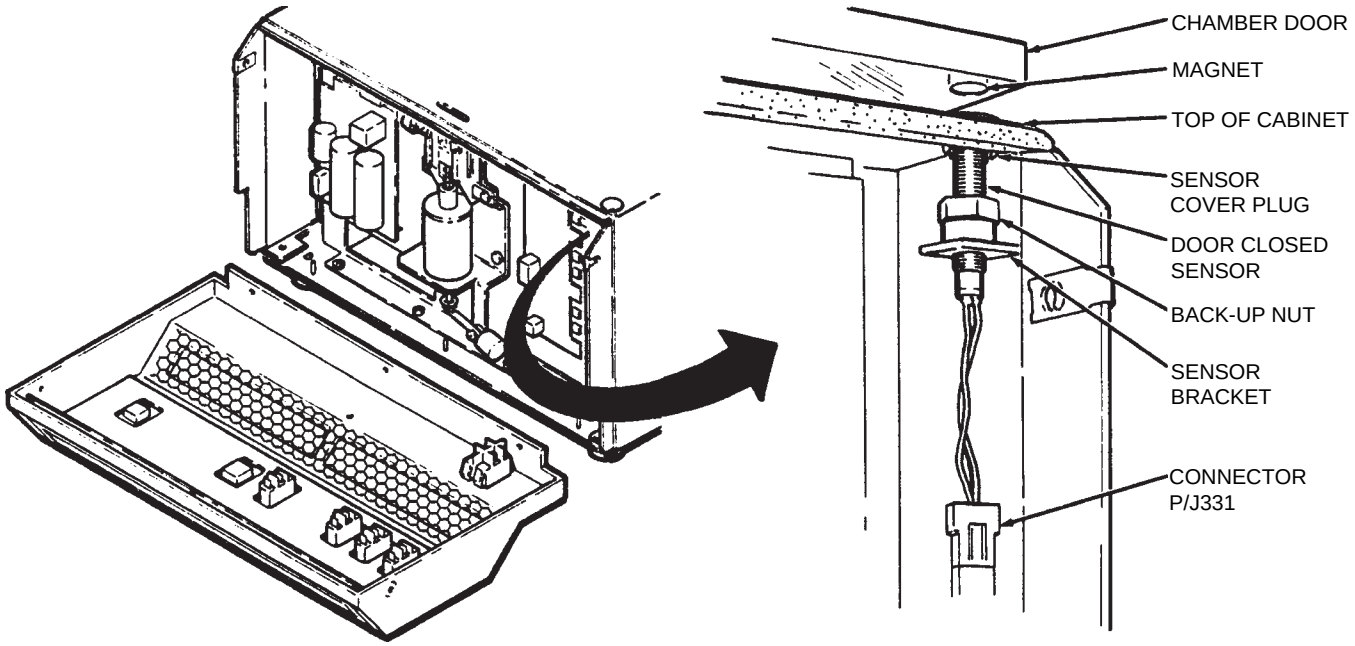

Figure 5-2. Door Closed Sensor Parts Location

5. Remove the two nuts from the new door closed sensor (one nut is not needed).

NOTE Replacement sensors are shipped without the connector body (P331) attached. *Do not* install the connector body to the wires of the door closed sensor until the sensor has been installed (step 7).

6. Lightly lubricate the threads of the new door closed sensor. This will permit easier installation.

7. Install the new door sensor as follows:

   a. Place the back-up nut on the top of the sensor bracket.

   b. Guide the door closed sensor wires through the hole in the cabinet, the back-up nut and the bracket. While holding the back-up nut (so that it is not touching the bracket), thread the sensor through the nut and the bracket until the top of the sensor is flush with the cabinet. Tighten the back-up nut against the bracket.

   c. Insert the pins at the end of the sensor wires into the connector body (P331, supplied). Pins should click into place and not pull out.

   d. Reinstall the sensor plug cover.

8. Reinstall the bezel, then plug in the centrifuge power cord.

5-7. Fuse Replacement

The fuses are replaced by removing the fuse block located in the power connector on the back of the TC6® (see figure 5-3).

To replace the fuses:

1. Unplug the power cord from the wall receptacle and from the power connector.

2. Squeeze the two tabs located on either side of the fuse block and carefully remove the fuse block from the power connector.

CAUTION
When removing fuses, do not remove the voltage selector from the fuse block (SN 9501733 and below only). To do so can alter voltage compatibility (refer to paragraph 2-4, Voltage Selection).

3. Gently pull the damaged fuse(s) from the fuse block. Discard.

4. Install only properly rated fuse(s). Fuses are Type T, 250 V, but change amperage rating depending on the voltage selected:

   - *100 - 120 setting* requires two 3.15-amp fuses (PN91428)
   - *220 - 240 setting* requires two 2-amp fuses (PN91203)

5. Reinstall the fuse block into the power connector and plug in the centrifuge power cord.

NOTE If fuses are blown repeatedly, it may indicate an electrical problem. Contact your local Field Service Engineer, distributor or agent for SORVALL® Products.

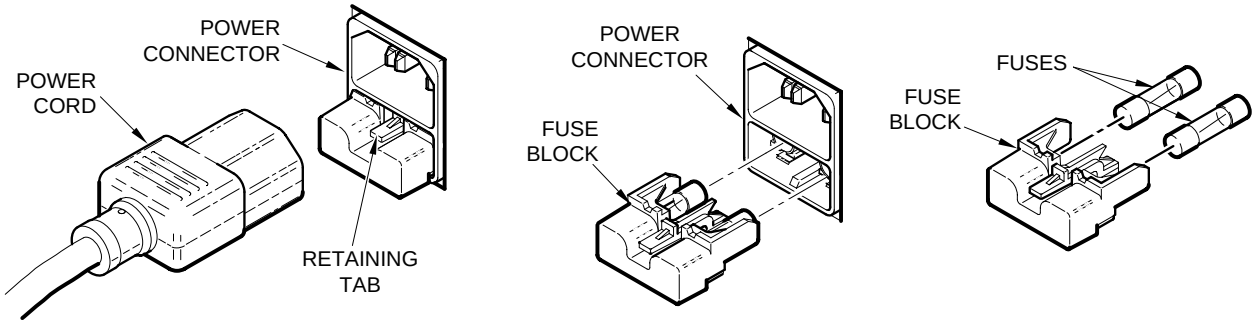

Figure 5-3. Fuse Replacement (50/60 Hz, SN 9501734 and above)

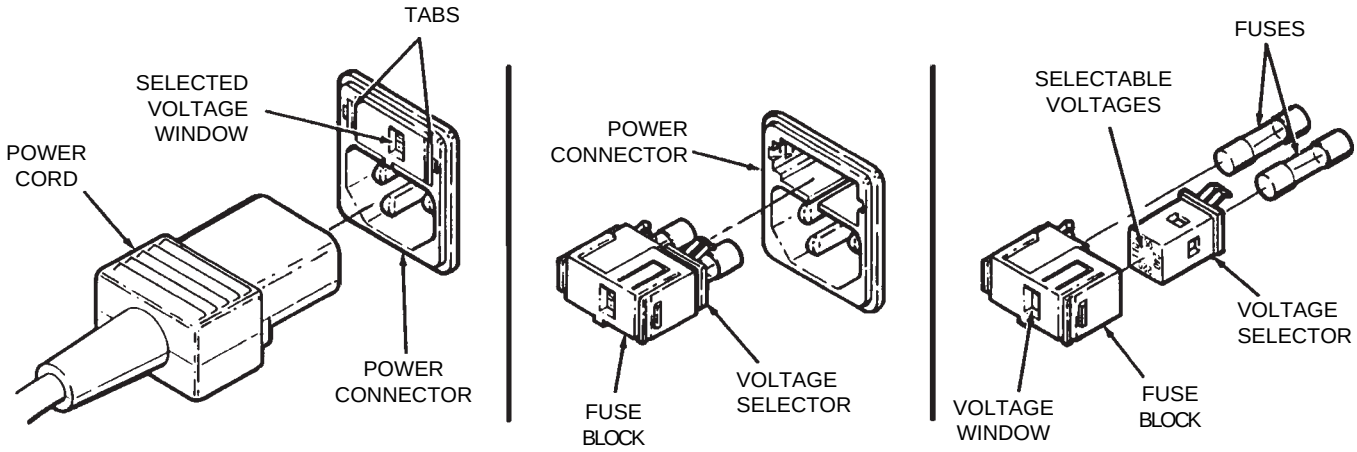

Figure 5-4. Fuse Replacement /Voltage Selection (50/60 Hz, SN 9501733 and below)

5-8. Voltage Selection (SN 9501733 and Below)

The voltage is set by the voltage selector (in the fuse block) located in the power connector on the back of the TC6® (refer to figure 5-4). The current voltage setting (100, 110*, 220, 230, or 240) is displayed in the window of the fuse block.

To change the voltage:

1. Unplug the power cord from the wall receptacle and from the power connector.

*For 120 V operation, the voltage selector is set to 110.

2. Squeeze the two tabs located on either side of the fuse block and carefully remove the fuse block from the power connector.
3. Gently pull the voltage selector from the fuse block.

4. Rotate the voltage selector until the desired voltage* is aligned with the window in the fuse block. Then, reinstall the voltage selector into the fuse block.

5. Check that the proper fuses are installed. Fuses are Type T, 250 V, but change amperage rating depending on the voltage selected:

   - 100/110* seting requires two 3.15-amp fuses (PN 91428),
   - 220/230/240 settings requires two 2-amp fuses (PN 91203).

   Change fuses if necessary.

6. Reinstall the fuse block into the power connector and plug in the centrifuge power cord.

5-9. Precautions for Handling of Printed Circuit Boards

WARNING

Some printed circuit board components can be damaged by static voltage; therefore, it is important to follow the precautions given when handling printed circuit boards.

WARNING

Never remove or install a printed circuit board while the centrifuge power cord is plugged in and the centrifuge power is ON. Failure to unplug the power cord can result in personal injury and/or damage to printed circuit components.

If it is necessary to replace printed circuit components, make sure the soldering iron used is properly grounded.

Observe all of the following precautions when handling printed circuit boards:

1. Wrap board in a conductive plastic packaging material, such as Velostat® by 3M Company, whenever the board is to be shipped or stored.

2. Always handle the printed circuit board by its corners only.

3. Cover all connectors with conductive plastic whenever a printed circuit board is out of the centrifuge.

4. You must be grounded when handling printed circuit boards, especially if working in a carpeted area. Use of an electrostatic discharge control product will protect against static voltages that can destroy some printed circuit board components.

*For 120 V operation, the voltage selector is set to 110.

WARNING

Read paragraph 5-9, Precautions for Handling Printed Circuit Boards, before beginning this procedure. Paragraph 5-9 contains important information regarding how to prevent personal injury and/or damage to the printed circuit board components.

5-10. Printed Circuit Board Replacement

1. Turn the centrifuge power OFF and unplug the power cord.
2. Remove the two phillips screws located on each side of the bezel. Carefully lift the bezel up to disengage it from the frame (but do not disconnect) and gently place the assembly so that the printed circuit (p.c.) boards are facing up.

NOTE Retain all hardware for reassembly.

Note the proper orientation of the connectors on each of the printed circuit boards.

3. Disconnect all connectors from the defective p.c. board.
4. Remove the screws that secure the p.c. board in place. Discard the damaged p.c. board.
5. Install the new p.c. board. Reconnect the connectors to the board noting the proper orientation of the connectors.
6. Reinstall the bezel securing it in place with the screws removed in step 2.

5-11. Motor Replacement

NOTE Retain all hardware for reassembly unless otherwise advised.

1. Open chamber door.
2. Turn centrifuge power off and unplug power cord.
3. Remove the motor cover and the chamber bowl with door gasket from the centrifuge.

NOTE Early model TC6® Centrifuges had a ground wire connected to the underside of bowl. The ground wire is no longer required and should be permanently removed.

4. Remove the two phillips head screws from the bezel. Lift off, but do not disconnect, the bezel.
5. Using an 11mm socket wr ench, remove the three nuts (and lockwashers, if any) from the motor mounting plate.

6. Disconnect P20 from the Motor Controls P.C. Board. Then, remove the wire harness from the plastic cable connector (located to the left of the Motor Controls P.C. Board). Carefully remove the motor (with the motor mounting plate) from the centrifuge.

7. Remove the nut (and lockwasher) that secures the motor mounting plate to the motor using a 10mm socket wr ench (the nut has left-handed threads). Discard the damaged motor.

8. Apply a few drops of Loctite® 222 (or Loctite® 242) to the motor mounting stud. Then, secure the motor to the motor mounting plate using the hardware retained in step 7.

NOTE Early model centrifuges do not have lockwashers installed on the three isolator studs that secure the motor mounting plate assembly to the frame or on the motor stud itself. However, before securing the motor mounting plate assembly to the frame, be sure to place a split lockwasher (PN 91180) onto each of the three motor studs and split lockwasher (PN 91312) onto the motor stud.

9. Position the motor/motor mounting plate assembly onto the shock mounts with the motor wires facing toward the front of the centrifuge.

10. Apply a few drops of Loctite® 222 (or Loctite® 242) to the three motor mounting studs. Secure in place using lockwashers and the hardware retained in step 5.

11. Route the motor wires through the front plate and reconnect P20 to the Motor Controls P.C. Board. Dress all wires and harness using the plastic cable connector located to the left of the p.c. board.

12. Reinstall the chamber bowl with door gasket and motor cover.

13. Reinstall the bezel securing in place with the two phillips screws retained in step 4.

14. Plug in the centrifuge power cord, install a rotor and perform a test run.

5-12. Fan and Grille Replacement

NOTE Retain all hardware for reassembly unless otherwise advised.

1. Open chamber door.

2. Turn centrifuge power off and unplug power cord.

3. Remove the motor cover and the chamber bowl with door gasket from the centrifuge (see figure 5-1).

NOTE Early model TC6® Centrifuges had a ground wire connected to the underside of bowl. The ground wire is no longer required and should be permanently removed.

4. Remove the two phillips head screws from the bezel. Lift off, but do not disconnect, the bezel.

5. Remove the two phillips screws located inside the front corners of the frame base.

6. Disconnect the door closed sensor.

NOTE It may be necessary to loosen the latch assembly.

7. Using a 7 mm socket wrench, loosen the two nuts, washers, and lockwashers from the front of the latch assembly. Then, loosen the two bottom phillips screws — this will allow proper clearance for the latch assembly. **Do not** loosen the two phillips head screws in center of latch assembly bracket – these screws secure the latching mechanism to the bracket, and *must not* be loosened.

8. Gently push the cabinet frame back to disengage it from the baseplate flanges (refer to figure 5-4). If necessary, use a rubber mallet to loosen the cabinet from the flanges. Then, lift the cabinet (with lid) off of the frame.

To replace the fan:

a. Using a 7 mm socket wrench, remove the four nuts (and lockwashers) that secure the fan in place.

b. Disconnect J131 (this connector is located near the motor).

c. Discard the damaged fan assembly.

d. Install the new fan making sure it is positioned so that the direction of air flow is out.

e. Reassemble the centrifuge reversing steps 1 through 8 (refer to figure 5-4).

To replace the grille:

a. Using a 7 mm socket wrench, remove the four nuts (and lockwashers) that secure the fan in place (note orientation for reassembly).

NOTE It is not necessary to disconnect P/J131 if you are replacing the grille.

b. Remove and discard the damaged grille.

c. Install new grille, reinstall fan, and reassemble the centrifuge reversing steps 1 through 8 (refer to figure 5-5).

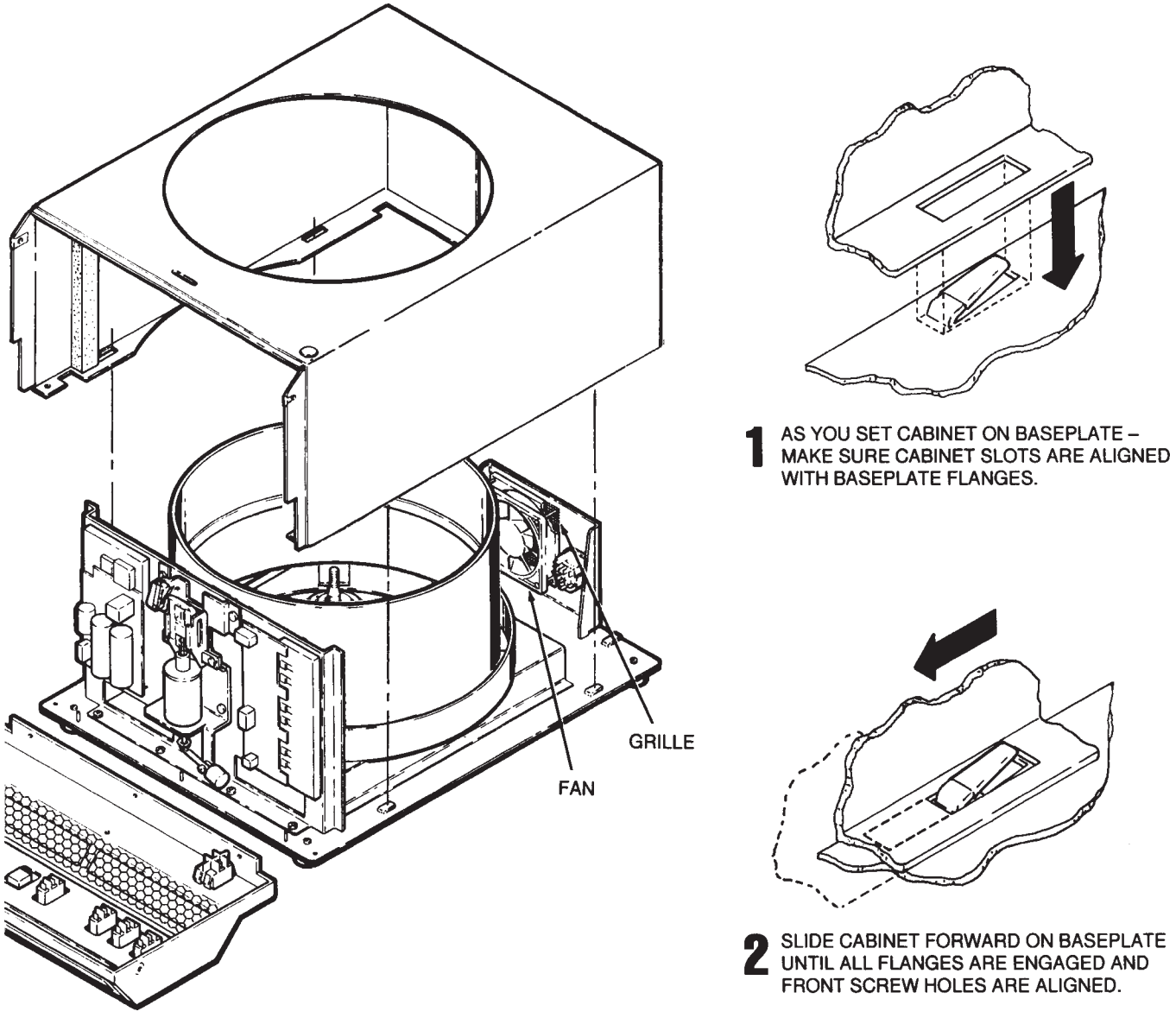

Figure 5-5. Reinstalling the Cabinet

5-13. Power Connector Replacement

NOTE Retain all hardware for reassembly unless otherwise advised.

1. Open chamber door.
2. Turn centrifuge power off and unplug power cord.
3. Remove the motor cover and the chamber bowl with door gasket from the centrifuge.

NOTE Early model TC6® Centrifuges had a ground wire connected to the underside of bowl. The ground wire is no longer required and should be permanently removed.

4. Remove the two phillips head screws from the bezel. Lift off, but do not disconnect, the bezel.
5. Remove the two phillips screws located inside the front corners of the frame base.
6. Disconnect the door closed sensor.

NOTE It may be necessary to loosen the latch assembly.

7. Using a 7 mm socket wrench, loosen the two nuts, washers, and lockwashers from the front of the latch assembly. Then, loosen the two bottom phillips screws — this will allow proper clearance for the latch assembly. **Do not** loosen the two phillips head screws in center of latch assembly bracket – these screws secure the latching mechanism to the bracket, and *must not* be loosened.
8. Gently push the cabinet frame back to disengage it from the baseplate flanges. If necessary, use a rubber mallet to loosen the cabinet from the flanges. Then, lift the cabinet (with lid) off of the frame.
9. Remove the 7/32 inch nuts from each side of the power connector.
10. Disconnect P/J41 and the ground wire..

11. Remove the defective power connector. Then, remove the fuse block and fuses from the defective power connector and install into the new power connector assembly (PN 78028, SN 9600946, 60 Hz and above).

NOTE SN 9501734 and above, 50 Hz instruments have filter (PN 78038) mounted with two M4 pan head screws (PN 91280) and two lockwashers (PN 63936).

12. Install the new power connector securing in place with the hardware retained in step 9.

13. Reconnect P/J41 and the ground wire.

14. Reassemble the centrifuge reversing steps 1 through 8.

NOTE When reinstalling the cabinet, be sure the slots of the cabinet frame engage the flanges on the baseplate. If necessary, use a rubber mallet to tap into place. Refer to figure 5-5.

5-14. Speed Potentiometer Replacement

NOTE Retain all hardware for reassembly unless otherwise advised.

1. Turn centrifuge power off and unplug power cord.

2. From the front bezel, use an Allen wrench to remove the set screw from the SPEED knob. Remove knob.

3. Remove the nut and star washer.

4. Remove the two phillips screws located on each side of the bezel. Carefully lift the bezel up to disengage it from the frame (but do not disconnect).

5. From the back of the bezel, remove the speed potentiometer — note the proper orientation of the wires to terminals, then cut the wires.

6. Strip approximately .6 to 1.3 cm (1/4 to 1/2 inch) of the insulation from the cut wires. Solder the wires from the harness to the new potentiometer.

7. Install the potentiometer and secure it in place with the hardware removed in step 3.

8. Reinstall the front bezel securing it in place with the hardware removed in step 4.

9. Turn the shaft of the potentiometer to zero (fully counterclockwise).

10. Open the chamber door and install a rotor with a full complement of buckets (4 each).

11. Set the TIME dial for a short run.

12. Slowly turn the shaft of the speed potentiometer until the speed stabilizes at 3000 rpm. Once the speed has stabilized, place the knob on the shaft so that the black line indicator is aligned at the "12 o'clock" position on the bezel overlay. Then, tighten the knob set screw; the dial is properly set.

Contents
Section 6. Troubleshooting

Table

Section 6: TROUBLESHOOTING

This section describes mechanical and electrical malfunctions that may occur in the TC6® Tabletop Centrifuge. Table 6-1, Troubleshooting Chart, may be used with the schematics and wiring diagrams provided to locate problem areas.

WARNING

Because the high voltages in this centrifuge can cause severe electrical shock, any repair or replacement procedures should be attempted by trained personnel only.

Table 6-1. TC6® Troubleshooting Chart

Problem	Probable Cause	Solution
No power to TC6®.	1. No ac supply.	1. Check supply ac for open breaker/fuse.
AC to centrifuge, but no display.	1. Low ac supply (less than 80% of nominal).	1. Advise customer of problem.
	2. Main switch off.	2. Turn main switch on.
	3. High ac, but fuse block set at low ac.	3. Most circuits will be destroyed. Replace damaged printed circuit board(s). Configure fuse block properly.
	4. Low ac, but fuse block set at high ac.	4. No damage to unit. Configure fuse block properly.
	5. Loss of 7 Vac supply, possible open transformer.	5. Isolate 7 Vac supply. Replace transformer if defective.
	6. Shorted 7 Vac to dc regulator.	6. Display and Control Printed Circuit Boards destroyed. Replace boards.
	7. Loss of dc output connection at power supply.	7. Repair/connect wiring.
	8. Input fuse too small, nuisance fuse opening.	8. Install correct fuses.

Table 6-1. TC6® Troubleshooting Chart (continued)

Problem	Probable Cause	Solution
AC to centrifuge, but no display. (continued)	9. 5 Vdc on display is greater than 8 Vdc.	9. Display Printed Circuit Board destroyed. Replace board.
	10. Loss of 5 Vdc supply.	10. Locate problem in 5V supply. Repair.
	11. Electrostatic discharge.	11. Display Printed Circuit Board destroyed. Replace board.
Display functioning, but centrifuge will not start.	1. Loss of 30 Vac supply.	1. Locate problem in 30 Vac supply. Repair.
	2. Shorted 30 Vac to dc regulator.	2. Motor Control Printed Circuit Board destroyed. Replace board.
	3. 5 Vdc on Control Printed Circuit Board surges to greater than 8 Vdc.	3. Motor Control Printed Circuit Board destroyed. Replace board.
	4. Loss of speed set pot.	4. Replace pot.
	5. START switch stuck OFF.	5. Replace switch.
	6. STOP switch stuck ON.	6. Replace switch.
	7. RUN command line is open.	7. Repair.
	8. 30 Vdc on Control Printed Circuit Board surges to greater than 40 Vdc.	8. Control Printed Circuit Board destroyed. Replace board.
	9. Door closed switch OPEN.	9. Switch defective or magnet missing. Replace.
	10. Latch lock switch OPEN.	10. Switch out of adjustment or defective. Adjust or replace.
Timer does not function correctly. 1. Timer does not work.	1. Loss of bit in timing string. Defective Control Printed Circuit Board or Timer Encoder.	1. Replace the Control Printed Circuit Board or Timer Encoder.

Table 6-1. TC6® Troubleshooting Chart (continued)

Problem	Probable Cause	Solution
Timer does not function correctly. (continued)		
2. Cannot set timer.	2. Loss of bit count. Defective Display Printed Circuit Board.	2. Replace the Display Printed Circuit Board.
3. Never starts or ends.	3. Loss of bit brake, PR, Timer clock, Time-out.	3. Replace the Display Printed Circuit Board.
4. Unable to run timer on forever or off forever.	4. Loss of set encoder. Defective Control Printed Circuit Board.	4. Replace the Control Printed Circuit Board.
5. Unable to set Hold.	5. HOLD switch stuck OFF.	5. Replace HOLD switch.
6. Unable to get out of Hold.	6. HOLD switch stuck ON.	6. Replace HOLD switch.
7. Delay of an internal timer bit.	7. Loss of bit in timing string.	7. Replace the Control Printed Circuit Board.
8. Timer stops run at 10 minutes.	8. a. Loss of U3 rectifier on Control Printed Circuit Board. b. Missing capacitor on Display P.C. Board.	8. a. Replace the Control Printed Circuit Board. b. Install a capacitor (22pf) across U2 pins 7 and 8 on the Display P.C. Board.
9. Timer stops in half the set value. Erratic operation.	9. Check for connection between pins 2 and 3 of U11 on the Control P.C. Board.	9. Install a jumper between pins 2 and 3 of U11 on the Control P.C. Board.
Door will not open at end of run.	1. Loss of 30 Vac.	1. Locate problem in 30 Vac supply. Repair.
	2. Loss of latch release signal.	2. Replace the Control Printed Circuit Board.
	3. Shorted latch release.	3. a. Latch solenoid shorted. Replace latch assembly. b. 10 amp fuse on Power Supply Board open. Isolate and repair.
	4. DOOR switch stuck ON. 5. DOOR switch stuck OFF.	4. Replace DOOR switch.

Table 6-1. TC6® Troubleshooting Chart (continued)

Problem	Probable Cause	Solution
Door will not open at end of run. (continued)	5. Loss of DOOR switch.	5. Replace DOOR switch.
	6. Loss of bit in timing string.	6. Replace Control Printed Circuit Board.
	7. Loss of tach signal.	7. a. Replace Control Printed Circuit Board. b. Replace Motor Control Printed Circuit Board. c. Replace motor.
Odd readings or missing READY or DOOR LED's on display.	1. Loss of segments	1. Replace the Display Printed Circuit Board.
	2. Open LED.	2. Replace the Display Printed Circuit Board.
Odd reading or missing LED's on SPEED display.	1. Bad ground to Control Printed Circuit Board.	1. Add a separate ground.
Rotor turns but no speed display.	1. Loss of a bit, 2 PPS (Pulses per Second) tach.	1. Replace Display Printed Circuit Board.
	2. Internal tach bit delayed.	2. Replace Display Printed Circuit Board.
	3. Loss of bit in timing string.	3. Replace Control Printed Circuit Board.
	4. Loss of tach signal.	4. a. Replace Control Printed Circuit Board. b. Replace Motor Control Printed Circuit Board. c. Replace motor.
Samples are overheated.	1. Loss of cooling fan power.	1. Replace Control Printed Circuit Board.
	2. Cooling fan not working.	2. Replace fan.
	1. 30 Vdc supply on Motor Controller Printed Circuit Board is less than 25 Vdc.	1. Locate problem in 30V supply. Repair.
	1. Speed set stuck at maximum.	

Table 6-1. TC6® Troubleshooting Chart (continued)

Problem	Probable Cause	Solution
Rotor will not reach top speed.		1. Replace Control Printed Circuit Board.
Rotor exceeds set speed.	2. Shorted RUN command on Control Printed Circuit Board.	2. Replace Control Printed Circuit Board.
	3. Loss of bit in timing string.	3. Replace Control Printed Circuit Board.
	4. Loss of tach signal.	4. a. Replace Control Printed Circuit Board. b. Replace Motor Control Printed Circuit Board. c. Replace motor.
	5. Shorted RUN command on Motor Control Printed Circuit Board.	5. Replace Motor Control Printed Circuit Board.
	6. Speed control stuck at maximum.	6. Replace Motor Control Printed Circuit Board.
	7. Loss of tach input.	7. Replace the Motor Control Printed Circuit Board.
Rotor speed erratic.	1. Output transistor problem on Motor Control Printed Circuit Board.	1. Replace the Motor Control Printed Circuit Board.
Unable to stop rotor.	1. START switch stuck ON.	1. Replace switch.
	2. STOP switch stuck OFF.	2. Replace switch.
	3. Shorted RUN command line.	3. a. Defective Motor Control Printed Circuit Board. Replace board. b. Defective Control Printed Circuit Board. Replace board.
	4. Speed Control stuck at maximum.	4. a. Defective Motor Control Printed Circuit Board. Replace board.
	1. Rotor/load out of balance.	b. Defective Control Printed Circuit Board. Replace board.

Table 6-1. TC6® Troubleshooting Chart (continued)

Problem	Probable Cause	Solution
Centrifuge vibrates when running.		1. a. Check rotor for balanced load. b. Make sure all buckets are properly placed. c. Clean rotor pins/buckets.
Centrifuge makes excessive noise.	1. Faulty motor bearings. 2. Faulty fan motor bearings.	1. Replace motor. 2. Replace fan.
Centrifuge will start with door open.	1. Loss of Door Closed or Door Latched switch signal. 2. Defective Control Printed Circuit Board.	1. a. Microswitch out of adjustment. Adjust. b. Door Closed Switch defective. Replace the switch. 2. Replace Control Printed Circuit Board.

Contents
Section 7. Maintenance

Section 7: MAINTENANCE

This section contains procedures for the maintenance of the TC6® Tabletop Centrifuge.

WARNING

Because of the high voltages in the centrifuge, untrained personnel must not attempt to test or repair any electrical circuits.

To remove the potential of electrical shock unplug the centrifuge power cord.

7-1. Routine Maintenance

a. Inspection

Inspect the centrifuge and rotors weekly for:

- signs of wear;
- scaling or pitting (especially if samples or cleaning agents are caustic);
- encrusted biological deposits; and
- general cleanliness

b. Cleaning

CAUTION

Chlorides are extremely harmful to aluminum alloy rotors and can cause stress corrosion cracking. Therefore, if chlorides are used to disinfect the chamber, be sure to rinse the chamber thoroughly with water to remove all of the chloride cleanser.

1. Rotor chamber

The rotor chamber should be kept clean and wiped dry. Wash the chamber with water and a mild, non-alkaline dishwashing liquid, then rinse and dry with a soft absorbent cloth.

Use 70% ethanol to disinfect the rotor chamber or a 2% glutaraldehyde solution to sterilize it. For general radioactive decontamination, use a solution of equal parts of 70% ethanol, 10% SDS, and water. Follow this with ethanol rinses, then deionized water rinses. Dry with a soft, absorbent cloth. Dispose of all wash solutions in proper containers for radioactive waste.

2. Rotors

Clean rotors with a clean cloth after each use. Once a week, or immediately if spillage has occurred, wash the rotor with a mild, non-alkaline household detergent and water, then rinse and dry with a soft absorbent cloth.

Regularly inspect all rotors used with the centrifuge for corrosion and wear (for example, pitting from contact with caustic materials). If a rotor shows signs of wear or corrosion, remove it from use and contact your local Field Service Engineer for SORVALL® products to have it inspected.

3. Drive Spindle

Before each run, wipe the spindle with a soft cloth before a rotor is installed to reduce the chance of the rotor sticking to the spindle. To keep the surface of the spindle smooth, polish occasionally with #400 Emery cloth. Always wipe the spindle clean after polishing.

4. Cabinet

The entire centrifuge surface should be kept clean. Clean the enameled cabinet panels with a household wax cleaner. Use a brush to help remove ground-in dirt. Rinse thoroughly with water immediately afterwards, especially if using solvent-based cleaners for difficult to remove stains.

Clean the chamber door with a soft, wet cloth and soapy water. Avoid using abrasive materials (for example, dry paper towels) and organic solvents (for example, acetone) on the dry surface.

c. Lubrication

All internal components are lubricated and require no further lubrication. The ball bearings in the centrifuge motor are permanently lubricated.

7-2. Preventive Maintenance

W A R N I N G

If the centrifuge has been used with radioactive or pathogenic samples, it may be contaminated. The centrifuge and rotors must be certified free of biological or radioactive contamination: a Decontamination Certificate must be filled out by the user. Appropriate precautions and decontamination procedures must be followed when servicing the centrifuge. *Do not service or repair any equipment for which the proper decontamination procedures have not been performed.*

The preventive maintenance checks of the centrifuge and rotors are performed on service visits as specified by a service contract. In cases where no service contract exists, the preventive maintenance procedures must be performed by qualified service personnel selected at the discretion of the user.

If the preventive maintenance checks reveal existing or potential problems with the centrifuge, perform the appropriate corrective maintenance procedures as outlined later in this section.

Use the Preventive Maintenance Checklist (a sample is included at the end of this section) to record the completion dates or procedures, pertinent data, and any comments relating to the maintenance and operation of the centrifuge and rotors.

a. Preliminary Checks

Paragraph 6-1 outlines the inspection and cleaning procedures that should be done routinely by the operator. Check for evidence that the procedures are being done properly. Discuss any potential problems with the operator and/or customer.

b. Rotor Inspection

1. Inspect all rotors used with the centrifuge for corrosion and wear (for example, pitting from contact with caustic materials).

2. Inspect the locking stud.

3. For sealed buckets: inspect the seal rings (if applicable).

4. Record the serial numbers of the rotors inspected. If any problems are discovered, note that fact on the checklist and inform the customer.

c. Prerun Checks

1. Door

   a. With the door open, the centrifuge should not start.

   b. With the door down but not latched, the centrifuge should not start.

   c. Place four pieces of paper equally spaced around the top of the open rotor chamber door. Close and latch the chamber door and pull outward on each piece of paper. All should fit evenly and create a frictional drag as they are being pulled. If door does not seal properly, check the door seal for cracks or breaks and replace if necessary.

WARNING

Before any centrifuge is serviced, it is extremely important that the centrifuge and wall receptacle are checked for ground continuity. Failure to do so could result in a serious electrical shock.

2. Centrifuge Ground Continuity

   Check that the ground lug of the electrical plug is properly grounded and is shorted to the frame of the centrifuge.

   To check ground continuity, unplug the centrifuge power cord and attach one probe of an ohmmeter to the ground lug on the power cord. Set the meter to its lowest resistance scale. Touch the other probe of this ohmmeter to the chassis of the centrifuge. The meter should show less than 0.1ohms.

   115V olt receptacle: Measure either side of the line-to-the-ground receptacle. Voltage should be 115V ac on one line and 0V ac on the other. If no voltage is measured, the receptacle is either not properly grounded or the power cord and/or plug is defective.

   220V olt receptacle: Measure either side of the line-to-ground receptacle. Voltage should be 115V ac on both lines. If no voltage is measured, the receptacle is either not properly grounded, or the power cord and/or plug is defective.

3. Centrifuge Environment

   Check that there is a minimum clearance of 10cm (4inches) on all sides for proper air circulation and safe operation. An ambient temperature of 35°C(95 °F) must not be exceeded.

4. Cooling Fan

   Check that it comes on with power.

5. LED Segments

   All segments light on SPEED, TIME, READY indicator light and DOOR indicator light LEDs.

d. Electronic Checks

1. Set the POWER switch to "I".

2. Press the DOOR switch to open the chamber door. Install the H-400 Rotor with four full buckets onto the drive spindle.

3. Set the run parameters: SPEED dial and TIME dial, to the desired settings for a normal run application.

4. Press the START switch.

5. Use a stopwatch to check the acceleration time. The time verified should be less than 45 seconds to 3500 rpm with full load. Accurate test results can be achieved with 100 ml of water in each of the four buckets.

6. When the rotor has reached the preset rpm value, verify the rpm reading using a strobe tachometer following the instructions supplied with the tachometer. Check the rotor through the viewing port located in the center of the chamber door. If verifying with a frequency meter, attach leads to test points labelled TACH on Control Printed Circuit Board. (Frequency recorded should be multiplied by five). The reading given by the tachometer or frequency meter should be in agreement with the SPEED display to within ±1%of the set run speed.

7. Use a stopwatch to check the deceleration time. The time verified should be less than 40 seconds from 3500 rpm with full load.

8. Press the START switch. Using a stopwatch, verify that the centrifuge turns off when the preset time has elapsed (±3seconds).

e. Motor System

1. Motor Bearings

   Remove rotor and spin shaft by hand. If the motor bearings are noisy or rough, replace motor.

2. Motor Plate Bushings

   Check motor mounting plate for uniform stiffness. Replace bushings if necessary.

SORVALL® CENTRIFUGES

Preventive Maintenance & Calibration Certification

TC6®

☐ **Preventive Maintenance and Calibration Certification** A & B

☐ **Repair and Calibration Recertification** B ONLY

Instrument Model:	Work Date:
Serial Number:	Report Number:

A. Preventive Maintenance

Preliminary Checks
- ☐ Proper cleaning
- ☐ Clean/lubricate motor shaft
- ☐ Hinge adjustment
- ☐ Latch adjustment

Rotor Inspection
- ☐ Locking stud and seal ring
- ☐ Rotor serial number _____

Pre-Run Checks
- ☐ Door seal
- ☐ Ground continuity
- ☐ Environment
- ☐ Fan
- ☐ LED's

Pre-Run Checks - continued
- ☐ Door open test
- ☐ Door down/not latched

Electronic Checks
- ☐ Acceleration time
- ☐ Verfy speed
- ☐ Verify time
- ☐ Deceleration time

Latch Checks
- ☐ Door open (no start)
- ☐ Open door (during run)
- ☐ Door opens (end of run)

Motor System
- ☐ Motor bearings
- ☐ Suspension/bushings

B. Calibration Certification

Test Parameters	Setting	Tolerance	Displayed	Error	After Cal	Passed (Initials)
Low Speed	1000 rpm	±1%				
High Speed	3000 rpm	±1%				
Time	10 min.					

C. Test Equipment Used

Type	Serial Number	Calibration Date	Calibration Due Date
Digital Multimeter			
Stopwatch			
Digital Thermometer			

D. Certified By:

_____
Printed name

_____
Signature

E. Certification Decal No.:

F. Instrument Certification Expiration Date:

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Section 8. Illustrated Parts

Figures

Tables

Section 8: ILLUSTRATED PARTS

This section contains illustrations and tables identifying the replaceable parts of the TC6® Tabletop Centrifuge. The illustrations indicate replaceable parts using item numbers which are keyed to accompanying tables. The tables, by item number, list the part number and description of each replaceable part.

When ordering replacement parts, be prepared to specify the part number, description, and quantity of each item desired, along with the centrifuge model (TC6®) and serial number.

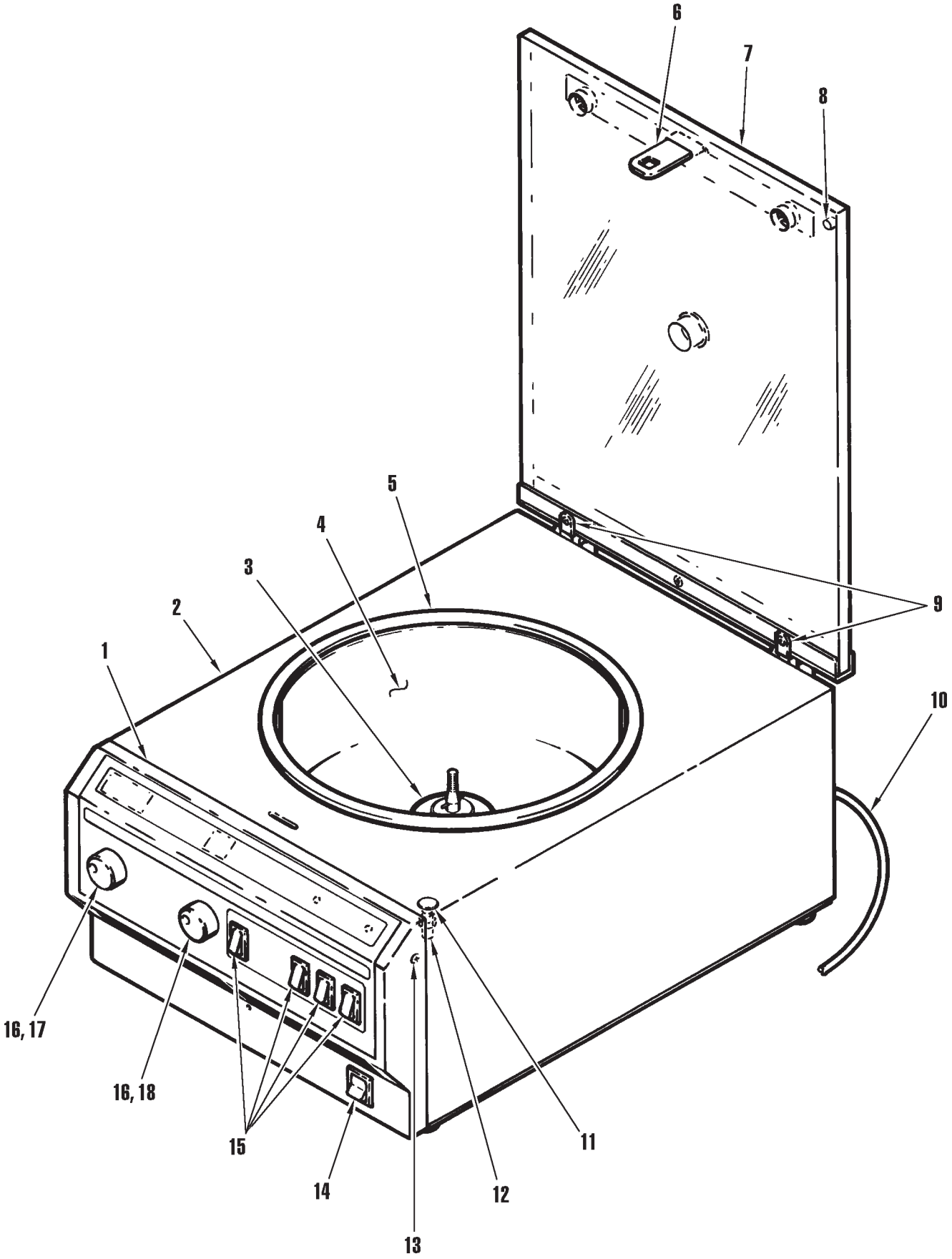

Figure 8-1. TC6® Main Assembly

Table 8-1. Parts: TC6® Main Assembly (keyed to figure 8-1)

Item Number*	Description	Part Number
1	Bezel - Overlay	**78306** **78145**
2	Cabinet Assembly (requires the following seven items)	78240
-	Label, Rotation Arrow	**62541**
-	Label, Warning – Operate only with chamber / gasket	78298
-	Label, Electrical Warning – Disconnect power	73184
3	Motor Cover	**78118**
4	Bowl Assembly	**78277**
5	Gasket, Door Seal	**78119**
6	Striker Assembly, Door	**78210**
-	Nut/ Lockwasher (2 required)	91230
7	Door Assembly without Striker (includes item 8)	**78023**
8	Magnet, Door Sensor (part of item 7) **	**91268**
9	Hinge, Door	**91170**
10	Power Cord: 125V, 10A (for 60Hz Centrifuges) 250V, 10A (for 50Hz Centrifuges)	**67080** **91605**
11	Plug, Door Sensor Cover	**66246**
12	Sensor, Door Closed	**78280**
13	Screw, 10-24 Gray	90882
14	Switch, Power, DPST	**91164**
15	Switch, Control, Momentary SPST	**91163**
16	Knob, Control	**78150**
-	Setscrew for knob	66995
17	Felt Washer (behind Speed Knob)	**92237**
18	Felt Washer (behind Timer Knob)	**92238**
-	Mechanical Override Key Kit	**12945**
-	Operating Instruction Manual	**78007**
-	Condensed Operating Instruction Sheet	78013

* A dash (-) indicates items not referenced in figure 8-1.

** If ordering a Magnet, installation requires adhesive: Loctite® Black Max, PN 69613.

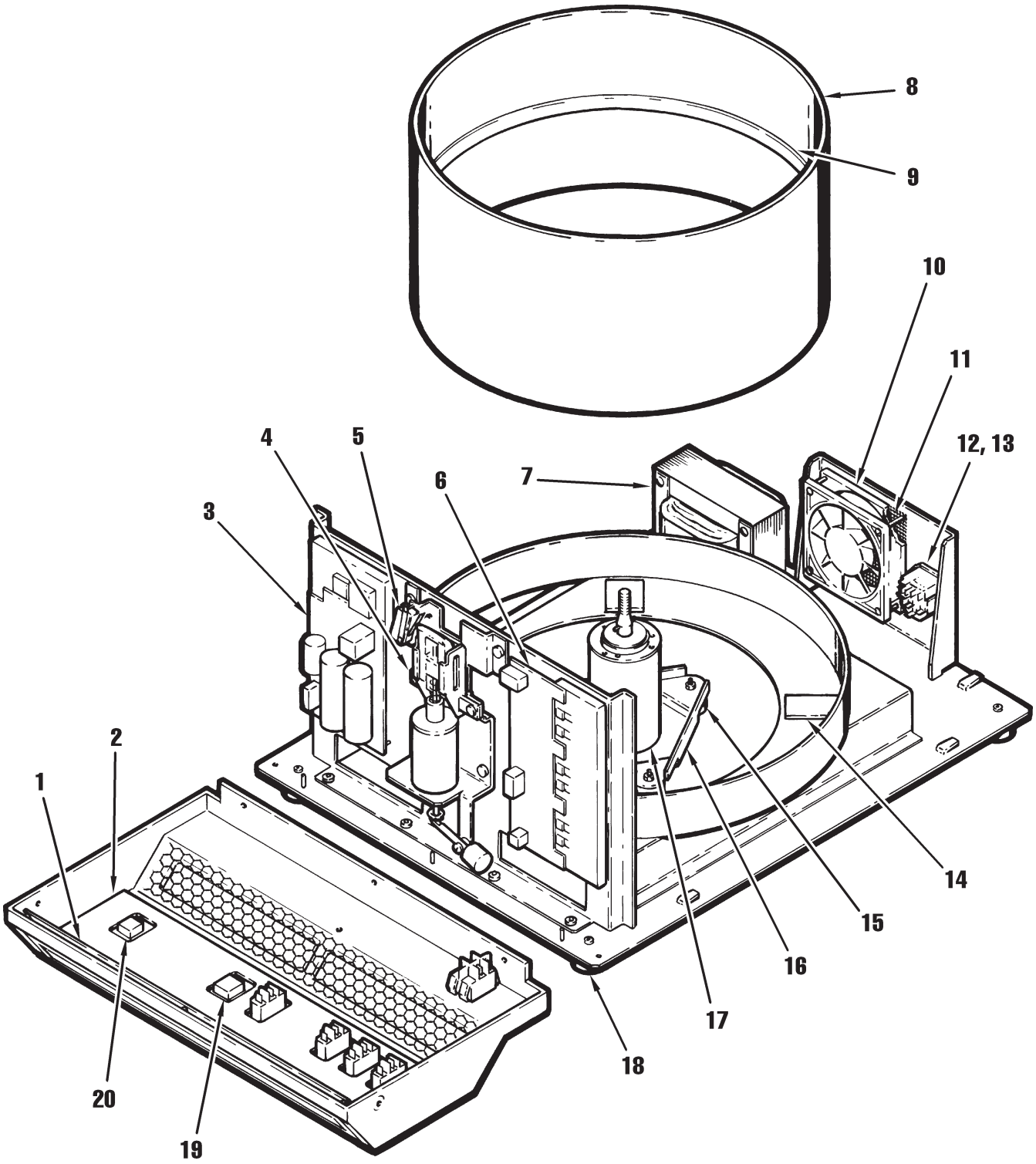

Figure 8-2. TC6® Chassis Assembly

Tables 8-2. Parts: TC6® Chassis Assembly (keyed to Figure 8-2)

Item Number*	Description	Part Number
1	Display Printed Circuit Board Assembly	**78178**
2	Control Printed Circuit Board Assembly	**78189**
3	Power Supply Printed Circuit Board Assembly	**78049**
4	Door Latch Assembly (includes switch from item 5)	**78314**
-	Kit, TC6 Latch, Sub Assembly (Plastic Assembly)	**78040**
5	Microswitch, Door Latch (switch is part of item 4)	**66753**
6	Motor Control Printed Circuit Board Assembly	**78230**
7	Transformer	**78036**
8	Guard ring (requires foam strips, item 9)	78102
9	Foam Strip, Guard Ring (2 required)	61624
10	Fan	**91187**
11	Grille, Fan **(No Longer Available)**	78090
12	Power Connector, 60Hz	**78028**
-	Line Filter, 50Hz	78038
13	Fuse, 5 x 20mm (2 required): 3.15A (for 100V-120V, 60Hz)	**91428**
	2A (for 220V-240V, 50Hz)	**91203**
14	Spacer Pad, Guard Ring	91310
15	Shock Mount, Motor	**91174**
16	Motor Mounting Plate	**78107**
17	Motor with Nut and Lockwasher	**78120**
18	Rubber Foot	**68568**
19	Timer Control Encoder	**91162**
20	Speed (RPM x 1000) Control Potentiometer	**91161**
-	Wire Harness Assembly	**78214**
-	Voltage Rating Label: for 60Hz Centrifuge	78270
	for 50Hz Centrifuge	78271
-	Label, WARNING – Use Only Fuse Type	78304

* A dash (-) indicates items not referenced in figure 8-2.

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For Ordering Information or to place an Order, contact:

SORVALL CUSTOMER SERVICE
31 Pecks Lane
Newtown, CT 06470-2337
FAX: (203) 270-2166
(203) 270-2210

For Applications Information, or for Technical or Service Information, contact either:

The **SORVALL APPLICATIONS LAB**,
or **SORVALL SERVICE & SUPPORT**
31 Pecks Lane
Newtown, CT 06470-2337
FAX: (203) 270-2115

In the United States, to place an Order, or for Applications or Technical Information, call **TOLL FREE**:

1-800-522-SPIN
(1-800-522-7746)

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